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Plumbing and House Drainage Problems

A SELECTION OF ARTICLES

FOR

PRACTICAL PLUMBERS

SIXTH EDITION

BEING A COMPLETE REVISION OF THE FOREGOING EDITIONS ISSUED BY THE "ENGINEERING RECORD" WITH IMPORTANT ADDITIONS COMPILED FROM

THE METAL WORKER, PLUMBER AND STEAM FITTER

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1906

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PREFACE

To present an old favorite with the practical plumber, revised and greatly increased in value, is a pleasant service. "Plumbing and House Drainage Problems" was originally compiled from the columns of the *Sanitary Engineer* and *Engineering Record* several years ago, to provide reliable and practical information for ready reference and assistance to plumbers who were confronted by problems with which they had had no previous experience. The valuable practical help it proved, alike to the old plumber and the beginner, gave the work a popularity which resulted in the sale of several editions; but a great need of revision was evident when the plates were purchased recently by *The Metal Worker, Plumber and Steamfitter.*

Nearly one-half of the present edition is devoted to new problems and special articles that have appeared recently in columns of that journal, giving the work a materially extended usefulness. A rearrangement of the subject matter has resulted in the removal of all that was obsolete or treated of practice no longer followed, and the space is given to articles on the latest and best methods. The old problems have been reclassified with new matter under each head, and new subjects have been given space, all arranged with a view to convenience for reference. The intent of the work is to furnish a fund of valuable information on a variety of practical subjects rather than a systematic treatment of plumbing and drainage.

This new edition, with its excellent selection of entirely new matter is offered with confidence that every practical plumber who reads the book will be benefited, and that it will prove a valuable reference in any plumber's library.

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DANGEROUS BLUNDERS IN PLUMBING

RUNNING VENT-PIPES IN IMPROPER PLACES—CONNECTING SOIL-PIPES WITH CHIMNEY-FLUES—BY-PASSES IN TRAP-VENTILATION, ETC.

So MANY examples of curiously outrageous plumbing have come, in one way and another, to our notice, that we have decided to publish some extracts from our collection. The drawings show so plainly at a glance what is wrong, to one who knows something of plumbing, that comment would be unnecessary, except that many of our readers, not being plumbers, nor well posted in such matters, may want us to point out wherein the work is so bad.

A certain class of defects of very serious character, generally produced by an anxiety to do good work, without considering the relation several fixtures bear to each other, has been brought to light by the New York City Board of Health, under the name "by-passes." That is, when the waste-pipes of several fixtures are so connected that they have a trap common to more than one of the fixtures, the attempt to ventilate the traps may produce an open path around some other trap into a room. Figure 1, showing this defect, was a country job. The arrows indicate plainly enough that it was decidedly wrong, for study of the cut will show that both fixtures have a common trap—that, namely, in the course of the waste-pipe, which was intended to protect the bath. But by bringing the waste-pipe from the basin into the *inside* or *house side* of this trap, it followed when the traps were ventilated that an open course was made by way of the vent-pipe con-

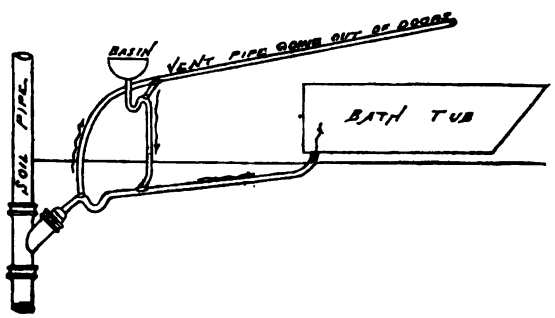


FIGURE 1.

necting the two traps, and then by the waste-pipe of the basin, around the trap which was supposed to cut the bath off from the drain, and the foul air in the house-waste system entered the bath-room through the outlet of the bath.

Figure 2 looks much like Figure 1, but is more stupid. It will be seen that there are no traps under any fixture except the water-closet, but the inventor of this system put a cowl on top of the soil-pipe, expecting to have an up-current always, and then connected the overflows of his basin and bath with a pipe leading to his soil-pipe, clearly supposing that he would always *draw air in* at the overflows, thus both preventing the escape of foul air at those openings and partially ventilating the room. But he forgot that no such constant upward current in the soil-pipe could be relied on, and when it failed the overflows became inlets for the foul air of the soil-pipe.

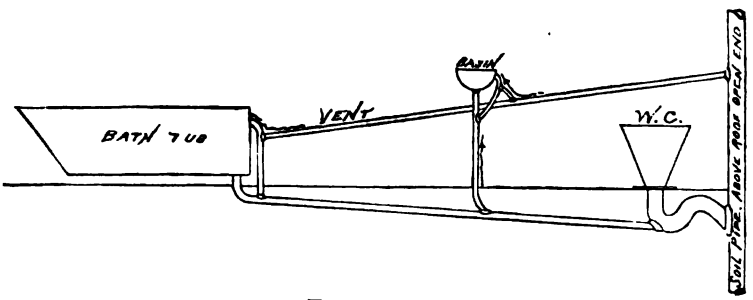


FIGURE 2.

In Figure 3 A and B represent the plumbing system in a New York building, where the value of traps was neutralized by attempting to use the trap-vent of one fixture as the ventilating-pipe of another fixture. B shows how this was done in the case of basins and urinals; A in the case of water-closet and urinal. In B a vent-pipe from the traps of several basins passed behind a row of urinals. The hood of each was connected with the trap-vent of the basins, which entered the soil-pipe. Of course an open way was thus provided for foul air through the urinal-hood.

In A the urinal was connected with the trap-vent of a water-closet, and the same mischief was done.

Mr. L. M. Hooper, one of the inspectors of the New York City Board of Health, has furnished additional examples of by-passes, as shown in Figures 4, 5, and 6. He explains them as follows:

"It seems hardly necessary to point out the objections to 'by-passes' from a sanitary point of view, when it is stated that a 'by-

pass' is an arrangement of traps and air-pipes by which sewer-air passes around the trap and so out into the building, thus practically making of no avail the many other precautionary measures, such as tight joints, etc., taken to prevent its entrance into the dwellings. One simple rule, if followed, will prevent a by-pass of the ordinary type. Water should never pass through more than one trap in reach-

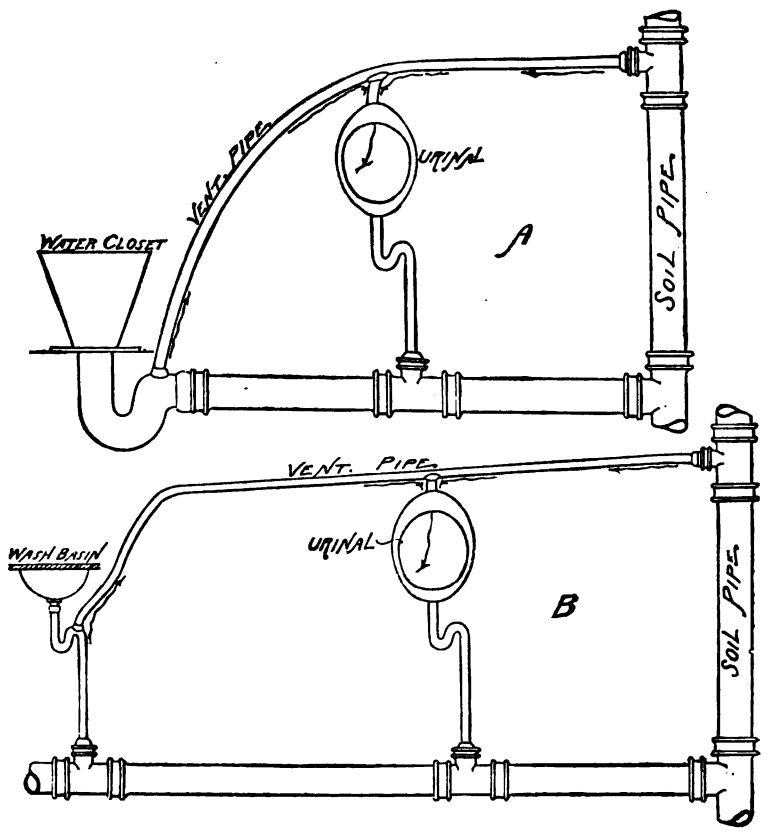


FIGURE 3.

ing the house-drain. If water after passing through the trap of its own fixture then passes through the trap of another fixture, and both traps are ventilated, there is sure to be a by-pass. One style of by-pass is shown by Figure 4. Here the water from the basin, in reaching the house-drain, passes through three traps, and the result is a double by-pass—one around the bath-trap and one around the water-

closet trap. As a rule, there will be as many by-passes less one as there are traps through which one discharge has to pass in reaching the house-drain. If Figure 6 be examined closely it will be seen that the water from basin 2 does not pass completely through the trap of basin 1, but enters it just below the seal. In this case the danger is not so imminent as in the others; that is, the water to make a complete by-pass, must pass entirely through the second trap. If it only passes half through —*i. e.*, enters it at its lowest point— the arrangement is not so dangerous. The greatest care should be exercised in overhauling old work. It is very common to hear the advice given, 'Well, trap that basin and ventilate it.' In nine cases out of ten it is the worst thing that could be done if nothing more is done. In almost every case in old work when the fixture is not already trapped, and often when it is, the trap of some other fixture will, upon examination, be found to act for it. The writer has one case in mind in which one water-closet trap answered for eight fixtures. A trap or vent-pipe should never be ordered for any fixture in an old house, without first tracing the branch waste pipe and seeing that it does not connect with the trap of any fixture."

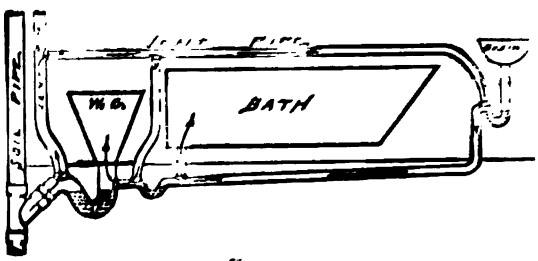


FIGURE 4.

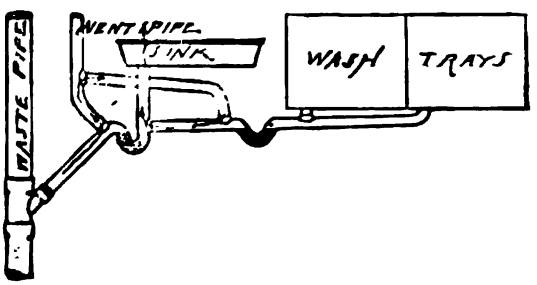


FIGURE 5.

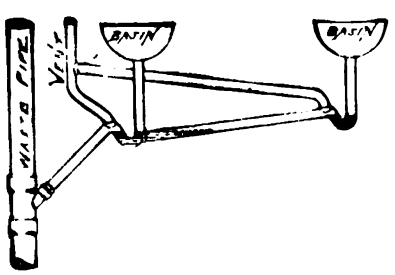


FIGURE 6.

A correspondent sends us a letter containing other illustrations of "by-passes." He writes as follows:

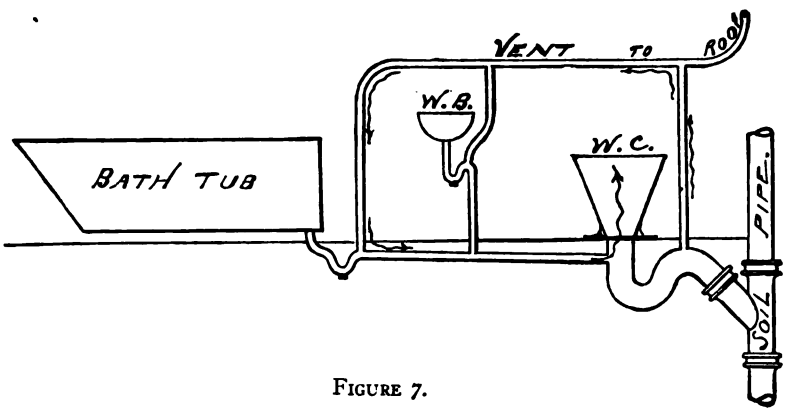


FIGURE 7.

"My attention has been drawn to some illustrations of defective plumbing, recalling to my mind several jobs of similar condition which I have seen while at work in buildings in this city. It is possible, however, that you have had illustrations of exactly the same defects as I now inclose you sketches of. In Figure 7 the original job had been done with but one trap—*i. e.*, that of the water-closet. On overhauling it had been air-piped, and the two remaining fixtures trapped and left in condition you see. In Figure 8 the hopper is made with side-outlet *a*, and the vent is run from it to the roof, a trap-vent on the same story connecting with it."

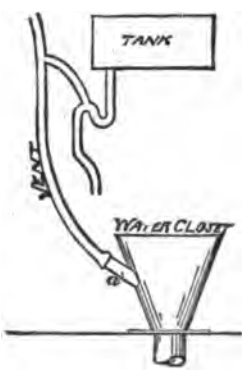


FIGURE 8.

Figure 9, from a town in Virginia, is a very good example of the mischief of connecting a bath-tub waste-pipe with the trap of a water-closet, for the evil was so manifest it could not be overlooked. The waste-pipe from the bath was itself untrapped, but connected with the heel

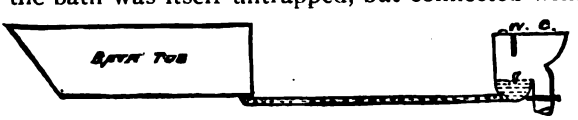


FIGURE 9.

of the trap under the closet. The pipe was so nearly level that at all times it was full of the nasty fluids of the water-closet, and a dis-

charge of the latter was pretty sure to throw part of this nasty matter up into the bath. It is a cardinal rule in plumbing that a bath and basin should always connect with the waste-system of the house separately from the water-closet, or at least that they should never connect with the trap of the closet, when their waste-pipes have to be nearly horizontal, as in almost every case they are. This illustration shows in an unusually forcible way the reasonableness of the rule.

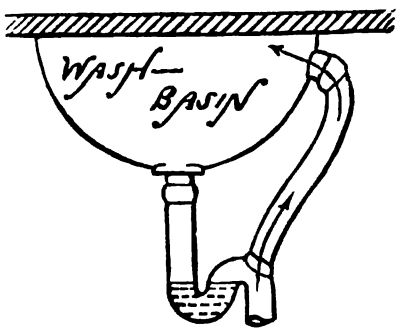


FIGURE 10.

The method of doing work shown in Figure 10 is an old acquaintance. This connecting of an overflow-pipe from a fixture to the waste-pipe in such a way as to make the trap of no use is forever turning up in different combinations. Sometimes, when it is not the overflow, it is a ventilating-pipe from the container of a closet, or some other pipe from a fixture which is perversely arranged to let in bad air. The wash-basin we show was found in a row of houses, whose plumbing generally was miserably done, in a town in Massachusetts. There was no trap on the house-drain, and hence gases from the sewer as well as from house-drainage system had free inlet through the overflow of the basin, which was connected with its waste-pipe *outside* of the trap-seal, as our illustration shows. Thus the trap was to all intents and purposes effectually done away with, and an open-pipe connection laid on to the sewer.

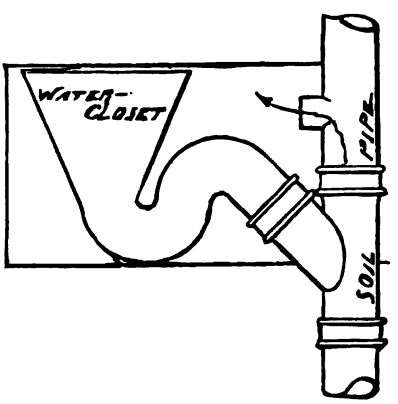


FIGURE 11.

In Figure 11, which should be compared with Figure 15, the workman tried to remove foul air from the casing around the water-closet with equal disregard of consequences. A short branch from the soil-pipe was carried through the casing and left open, with the

idea that the up-draught in the soil-pipe would draw the air from the casing into the pipe, but the usual result followed. The soil-pipe air frequently came out of the branch into the casing and room.

Figure 12 shows what clumsiness did in a house on Second Avenue, in New York City. An old pan-closet, in a dark, unventilated central room, such as is common in many New York houses, had been filling the hall with a terrible odor for some time. Finally the owner of the house sent a plumber to fix it. The cause of the smells then became plain enough. Under the closet was a safe, and from this safe led a waste-pipe into the heel of the water-closet trap. The level of the safe was but little above the top of the trap, which had been partially clogged up by things thrown into the closet. The result was that every time the handle of the closet was pulled, the discharge from the pan caused a jet of filth to shoot up from the trap through the safe-waste into the safe. This was practically illustrated by the plumber who was sent to make repairs, and it had gone on until the safe had filled, overflowed onto the floor, and leaked down between the floor-beams. The whole space inside the closet-casing was a wet mass of nastiness, which had filled the upper floors of the house with foul smells for several weeks. Yet this so-called plumber insisted that the work in this house was a good job!

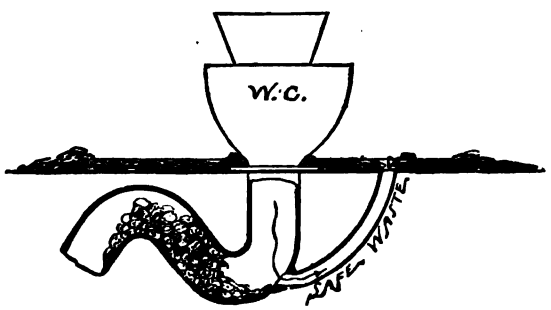


FIGURE 12.

Figure 13 shows an arrangement even worse than the former. In this case the waste-pipe from the safe under the water-closet was taken directly into the soil-pipe, completely neutralizing the trap under the water-closet, and giving an opening for the foul air in the soil-pipe to enter the space within the water-closet casing, not shown in the drawing, whence it would readily enter the water-closet room and spread through the house.

Figure 14 was discovered by a well-known master plumber of New York City. It is drawn to represent the condition which he

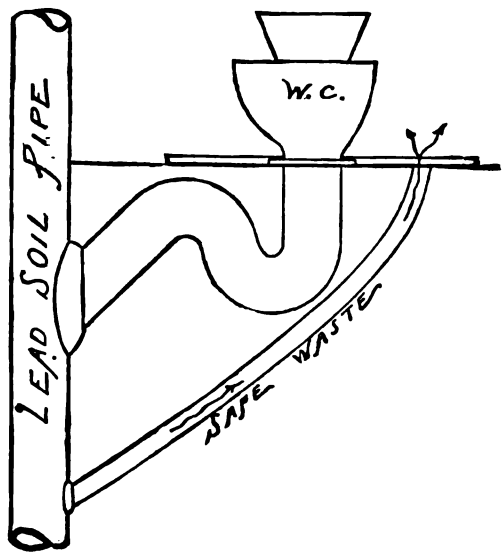


FIGURE 13.

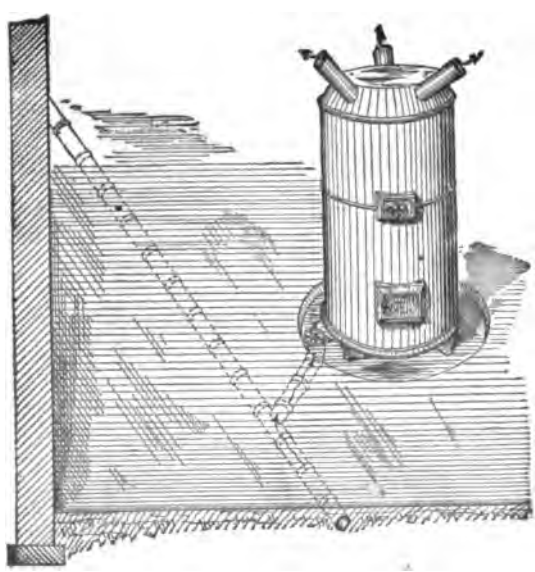


FIGURE 14.

found when called in to discover and remove the cause of foul smells which permeated a residence in the fashionable quarter.

The house being built on a damp foundation, a drain to remove the ground-water had been put in, as shown by the dotted lines. This drain connected with the street-sewer directly without a trap, which, indeed, without some means of preserving its seal against evaporation, would have been of little use. The main line of drain not removing all the ground-water which collected in the ash-pit of the furnace, a branch drain was taken, without a trap, from it to the ash-pit. Mark the result. When the furnace was fired up in the autumn, a part of the air-supply was sucked, as by an air-pump, directly from the public sewer through the branch-drain, and these foul gases were distributed all over the house through the hot-air pipes. Unfortunately, this, though perhaps the worst, is not an isolated case of a furnace taking its air-supply from a drain.

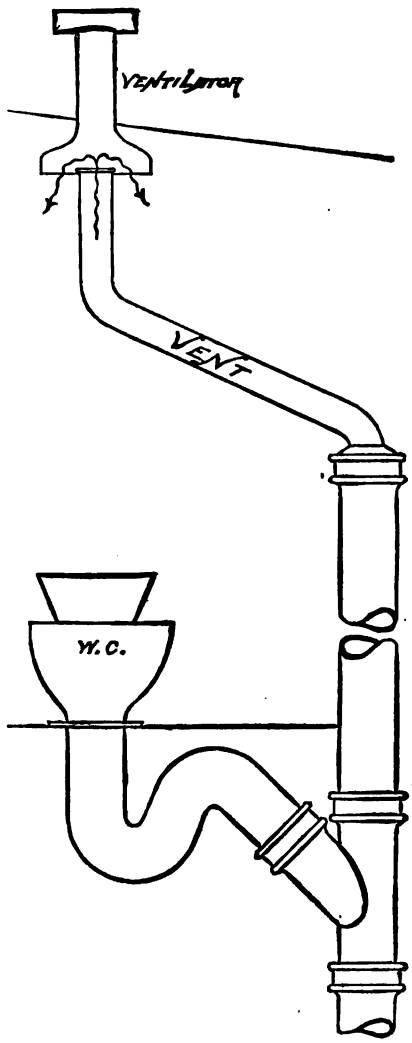


FIGURE 15.

Figure 15 is ingeniously bad. It was discovered by a journeyman plumber in the employ of one of the prominent plumbers of New York. By some process of reasoning the workman who did it had come to the conclusion that he could make one and the same ventilating-hood serve for his soil-pipe and for his water-closet room. He arranged it as shown in the drawing. From the top of the soil-pipe he took a vent-pipe to the under part of

a ventilating-hood. This hood was open at the bottom to ventilate the room, and consequently there was produced a very good means of bringing the soil-pipe air first into the hood and then into the room, as the arrows indicate.

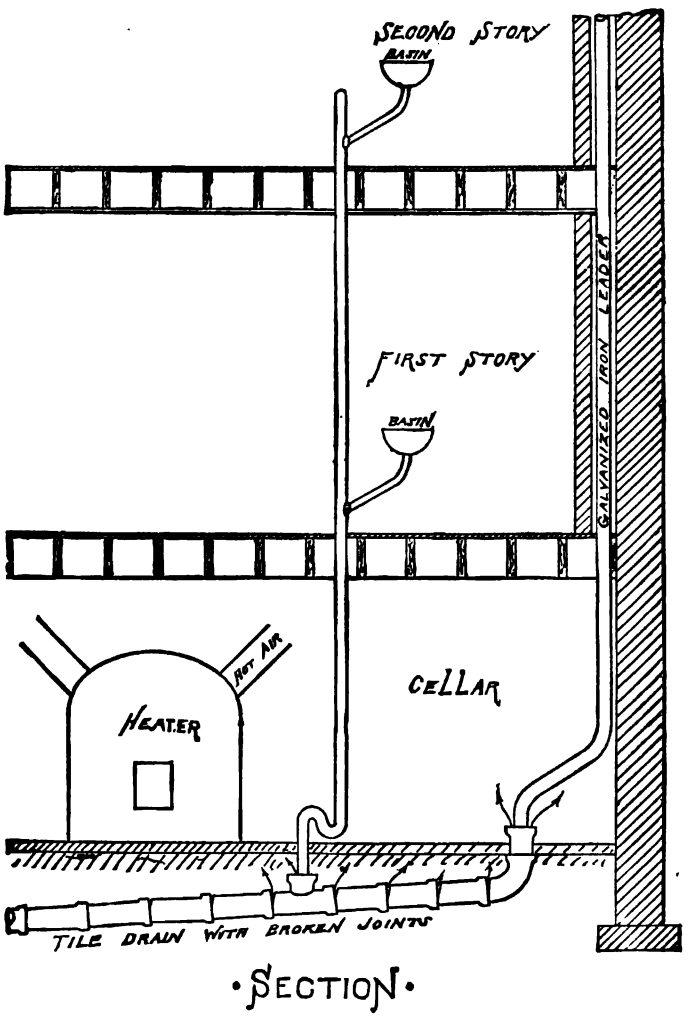


FIGURE 16.

Figure 16 shows how a dangerous condition was produced in a Philadelphia house by a somewhat different combination of causes. A tile-drain below the cellar-floor was broken and had imperfect joints. Then into this drain was brought a galvanized-iron rain-

leader from an extension. The joint where the leader entered a hub on the drain was imperfect; the leader itself was not tight, and was carried down between the wall and the studding, so that any foul air which passed into the leader from the drain found exit into the space behind the studding, and without much difficulty entered the house. At the same time the foul air of the drain was drawn from the imperfect joints and cracks into the heater as a part of its air-supply, and so sent over the house. Another clumsy feature about this job was the connecting of two wash-basins on upper floors with their waste-pipe without traps. The only trap between the basins and the drain was placed near the foot of the waste-pipe. Such an arrangement, of course, gave free access into the room of any smells from a long and dirty stretch of pipe, extending from the highest basin to the cellar, and having no trap to cut it off from the house.

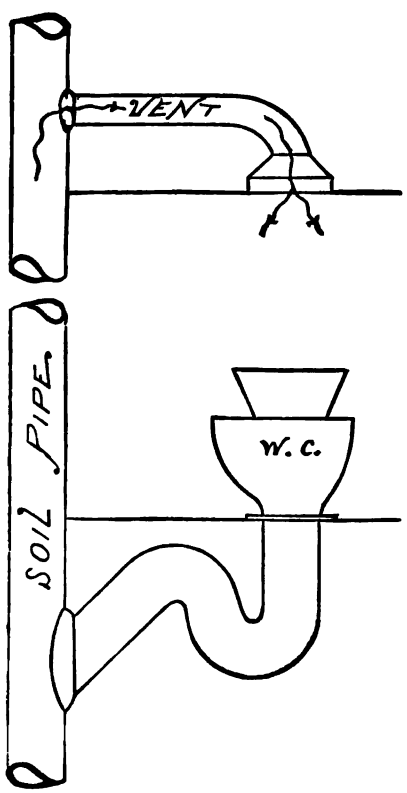


FIGURE 17.

In attempting to secure the ventilation of a water-closet room an economically inclined workman produced the condition shown in Figure 17. The soil-pipe running up above the roof with open end, it was plainly inferred that if the room was connected with it the room itself would be ventilated by reason of an up-draught, which was supposed to always exist in the soil-pipe. Accordingly a ventilating opening was made in the ceiling of the water-closet room, and a ventilating connection put between this opening and the soil-pipe. The result was, of course, that very often the currents of air in the soil-pipe were downward, and its foul air and smells passed into the room.

Figure 18 may be taken as a type of what has unfortunately been a common error. It is undoubtedly a good thing to ventilate the con-

tainers of pan-closets, if that is properly done, and that form of closet is used, but the container must then be connected with an independent flue or a pipe having no connection with the drainage system. Nevertheless, so-called plumbers take the "short-cut" method, and connect the container with the soil-pipe direct, or with the trap-ventilating pipe, which is equally bad, and so, of course, do away with the protection afforded by the trap of the water-closet; for the container vent-pipe offers a direct path for the soil-pipe air into the container, and there is no efficient protection to prevent its passage from the container into the house. This is the case with the work shown in the cut, where, it will be seen, a vent-pipe from the container of the water-closet connects directly with the soil-pipe.

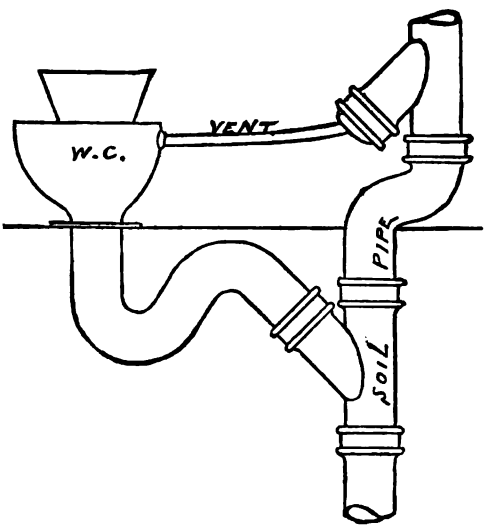


FIGURE 18.

Figure 19 contains its own explanation so clearly on its face that a definition is hardly necessary. One of the tubs of a set of wash-trays was connected into the *top of the trap*, which was common to all three. Of course, such a connection being outside of the trap-seal, an open course was provided for the bad air from the drains into the kitchen by way of this tub.

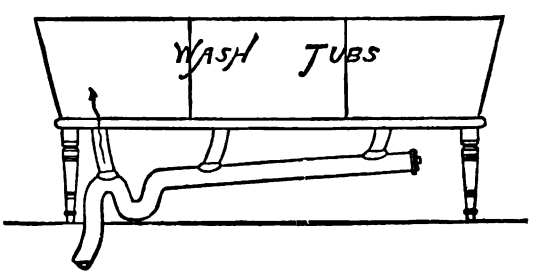


FIGURE 19.

Figure 20 shows a case where the soil-pipe terminated in a dead-end, and a branch-vent had been carried from it into a chimney-flue. It afterward proved that on this same flue was the fireplace of a lower room, and the result was that, the flue being seldom heated, foul odors poured from the drainage system out of the fireplace in such strength as to make the room uninhabitable. The job in which this occurred was in many respects a bad one, but this feature was perhaps the most striking about it, and was a very good illustration of the whole class of work of this kind.

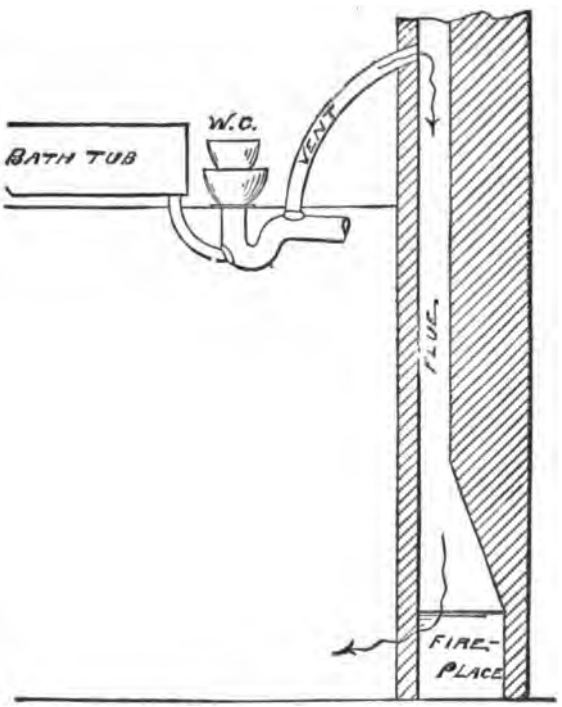


FIGURE 20.

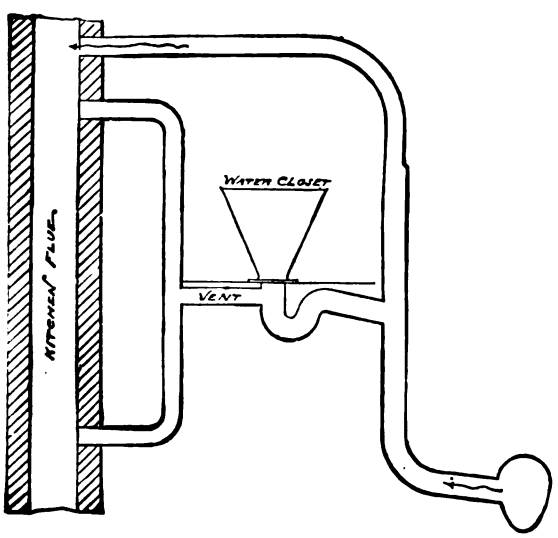


FIGURE 21.

Figure 21 is an illustration of a part of the plumbing in a tenement-house. It will be seen that there is no trap between

the house and the sewer; that the chimney flue is relied on to act as an efficient pump to always maintain a current from the sewer through the soil and waste pipes *outward,* and also to remove foul air from the hopper-closets which are connected with the same flue. The danger of the arrangement is apparent. Should the flue fail to draw for any reason, the connections with the hoppers serve as open roads for the passage of drain-air into the building around all traps, to say nothing of the possibility of escape of foul air through chimney-holes and fire-places.

When the so-called plumber who did the job shown in Figure 22 designed it, he planned a variation on the ordinary chimney-ventilating system, which had disastrous results. There was ready to his hand, near the foot of the vertical soil-pipe, a joint into which a waste from a sink had once been inserted. By connecting a galvanized-iron pipe with this and with a chimney-flue he proposed to ventilate the plumbing-system of the house. The result, however, was that he converted the bottom of the chimney into a cess-pool; for when the water-closet was discharged a part of the contents passed through the perfectly horizontal ventilating-pipe into the chimney, and there the matter gradually accumulated, until at the time of inspection the flue was filled nearly up to the vent-pipe. Yet the owner of this house, even when the state of things was shown to him, could not be convinced that the rational system of plumbing proposed as a substitute was necessary, and may have gone on using his chimney for a cesspool to the present time.

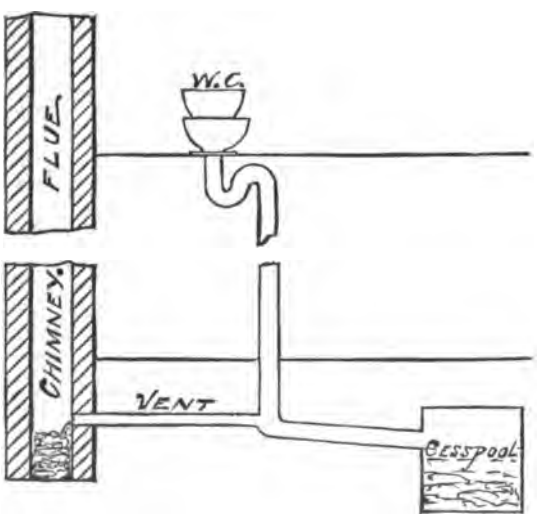


FIGURE 22.

Figure 23 shows a system of plumbing which was recently discovered in a row of houses in the vicinity of Boston, Mass. It forcibly illustrates the saying, "A little knowledge is a dangerous thing."

We wish to direct the reader's attention first to the 3-inch pipes

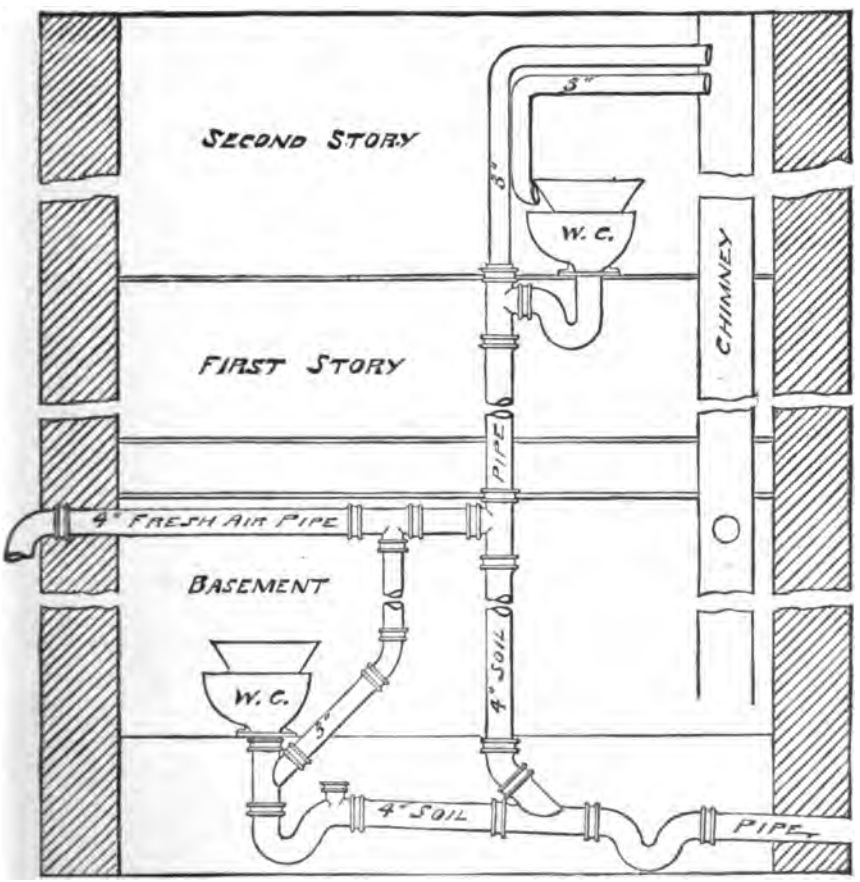


FIGURE 23.

above the upper water-closet. One of these, it will be seen, is the ventilating-pipe from the soil-pipe; the other is intended to remove bad air from the casing of the water-closet. Both terminate in a chimney-flue, and a few inches from each other. This flue was not heated. Of course the intention of the professed plumber who did this is plain enough. He expected to have a current of air through his soil-pipe and through his closet ventilating-pipe *outward and upward,* but it is almost a certainty that in some conditions of the at-

mosphere and wind a down draught in the chimney would result in carrying the foul air of the soil-pipe back through the closet-vent into the casing and the room. And if a fire or stove in or near the water-closet room were drawing in air to supply combustion, there would be danger that a part of that air would be drawn from the soil-pipe through the closet-vent. Such an arrangement, as we have again and again pointed out, is unsafe and not to be tolerated.

It will be noticed further, that from the 4-inch fresh-air pipe to the left a 3-inch pipe is taken to ventilate the space between the pan and trap of the lower water-closet. Now, should the end of this air-pipe which goes out of doors be stopped up temporarily by a fall of snow, a mischievous boy, or by any other cause (and such temporary stoppages of air-pipes are of frequent occurrence,) then the water, paper, and fæces from the upper closet, while falling through the upper portion of the soil-pipe, will drive the air in the soil-pipe before it and through the 4-inch air-pipe and 3-inch vent of the lower closet. The only obstacle to the passage of this air into the basement will be the shallow seal of the water-closet pan, which will break before either of the traps shown in the lower part of the drawing.

Finally, after a discharge from the upper water-closet has passed the 4-inch branch air-pipe, the air driven before it is compressed in the air-bound space between the two traps and the lower part of the soil-pipe, and the seal of one or the other trap will be probably forced. This would be prevented were there an air-inlet or foot-vent inside the trap at the lower right hand of the sketch. Indeed, this job shows at a glance one of the purposes of the foot-vent, while what has been said about the ventilating-pipe of the lower water-closet enforces once more the sanding rule, that if receivers of water-closets, or spaces generally between fixtures and their traps, are to be ventilated, the ventilating-pipe must not connect with the drainage system.

A CASE OF RECKLESS BOTCHING.

Q. I WAS lately called to examine a house, the occupants of which complained of bad smells, and in which I found one of the most expensive of the modern closets set, as in the accompanying sketch. The only ventilation to the soil-pipe was the 1¼-inch pipe D, which was branched out of the trap A, as shown. At B the waste-pipe from the basins was simply let into a hole cut in the iron pipe E, and an attempt was made to solder a joint at that point. You will also notice that the pipe C, which should extend independently out of doors, is branched into the apology for a continuation of the

soil-pipe. Is it not high time that some one should have authority to stop men who commit such folly from working at the plumbing business?

A. We understand that the man responsible for this work is now dead, so as there is no danger that he will ever commit any more similar blunders, we may briefly point out the most glaring defects in this piece of botching for the information of such of our readers who do not fully comprehend the sketch. (1) The soil-pipe should be carried through the roof, the pipe D being of little benefit. (2) The pipe C, intended as a vent for the space between the water in the trap A and that in the bowl, should be extended out of doors, unless a convenient hot-flue could be used for that purpose. When it is connected to the continuation of the waste-pipe, the benefits of the trap A are neutralized, and the drain-air conveyed to the pot of the water-closet, and could gain an entrance to the house in the event of the water being out of the bowl. If the soil-pipe had been continued up through the house the two basins, which seem to have been located quite close to the water-closet, could have been drained into that pipe. Each of the traps should be ventilated, likewise the trap A under the water-closet.

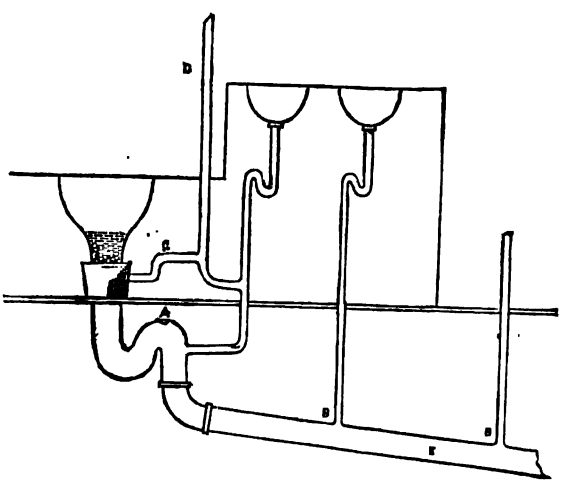


FIGURE 24.

The defects pointed out above might be attributed to gross ignorance, but the making of a connection of lead waste-pipe with iron soil-pipe in the manner described by our correspondent looks like reckless rascality. It is probably safe to say, what every plumber knows, that such a connection should have been into a Y-branch, with a brass or copper ferrule calked into it, on which the lead pipe should be properly soldered.

A STUPID MULTIPLICATION OF TRAPS.

A CORRESPONDENT writes a letter which may properly be inserted in this place. He says:

"I send you a sketch of some plumbing-work which came under my notice recently, as it was being overhauled. Originally the drum-trap (pot-trap) at kitchen-sink connected directly by a 2-inch pipe with the 6-inch earthenware drain below the cellar-floor. The refrigerator-trap also connected to drain by a 1½-inch pipe. Neither trap was ventilated. This latter was soon disconnected and made to discharge in an open pail, which was emptied every day. Eventually the house-drain becoming clogged with grease, the plumber advised putting in a grease-trap. This sketch shows the result of his labor. Not only did he put a grease-trap (not ventilated) on the sink-waste, but also added a drum-trap to the refrigerator-waste and discharged it into the grease-trap. This job has just been overhauled, a 4-inch vent carried from grease-trap to roof, and an open tray put on the line of refrigerator-waste, so as to entirely disconnect it."

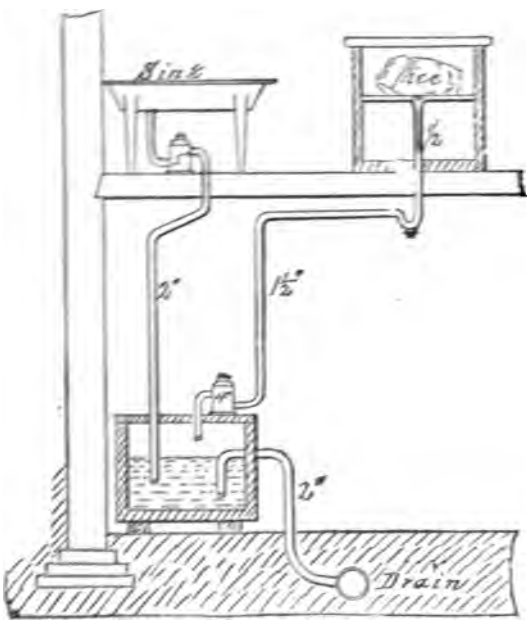


FIGURE 25.

The multiplication of traps with air-bound spaces between them here shown is a flagrant case of stupidity. No such duplication of traps should be allowed. The better way is to terminate the wastes that deliver into the grease-trap above the water-line.

PLUMBING BLUNDERS IN A GENTLEMAN'S COUNTRY HOUSE.

IT will be noticed that the man who did this work carried the vent-pipe A (Figure 26) into the continuation of the soil-pipe instead of

out of doors, thus virtually neutralizing the benefits which the water-closet trap was intended to afford.

The ¾-inch pipe B also affords direct communication between the soil-pipe at one end and the bath-overflow and inlet at the other, which, under less favorable conditions, might produce serious results. This is only another evidence of how gentlemen, anxious and willing to pay for what is right in their plumbing arrangements, are the victims of ignorance and thoughtlessness. It also shows how much more important it is to have intelligent workmen than expensive appliances.

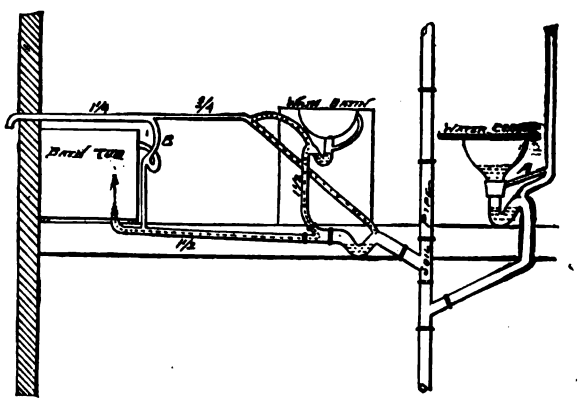


FIGURE 26.

Figure 27 illustrates the correct manner of arranging the traps and trap-ventilation. A reference to the previous sketch will indicate the points of difference.

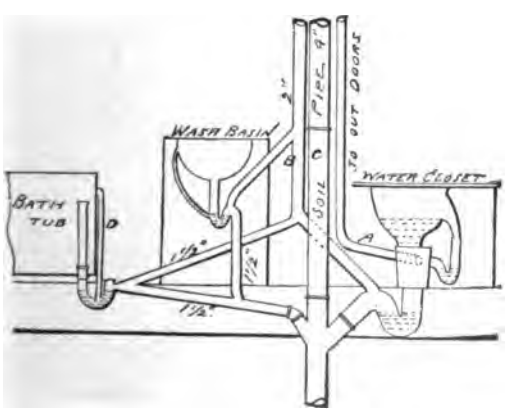


FIGURE 27.

It will be noticed, first, that the vent-pipe A from the receiver of the water-closet does *not* enter the soil-pipe, but leads independently to out of doors; secondly, the several traps are placed directly under the fixtures they are intended to serve.

The bath-trap is a half-S one, with a trap-screw close to the end of the bath and above the lead safe, the vent being close to it. As the

least likely to get foul or offensive, we show a standing "overflow and waste;" if this is considered in the way and troublesome, then the overflow from the bath should be run as indicated by the dotted lines. The vent-pipe B, with which the vents from the several traps communicate, can run independently through the roof, but in this climate we should prefer to have it join the soil-pipe above, when any drainage enters the latter, the soil-pipe not being so likely to get closed by ice forming as the smaller pipe would be. The end of the soil-pipe should be without a bend or hood, as in this case there is no danger of articles being thrown down it.

A TRAP MADE USELESS BY IMPROPER ADJUSTMENT OF INLET AND OUTLET PIPES.

THE accompanying drawing shows what was found in an uptown house in this city by a plumber who was called in to mend some leaky pipes. The pipe from the basin is supposed to extend down into the "round" or "bottle" trap, as is indicated by the dotted lines. The overflow-pipe entered the trap above the water-line, at the same level as the outlet, as shown, and the plumber who discovered the case and reported it to us stated there was a draught out of the overflow strong enough to blow out a candle. When our representative went to verify the matter he found the overflow closed by paper carefully pasted over it on the inside of the basin. This had been done by the occupants to keep out the smell, which was reported to be very bad.

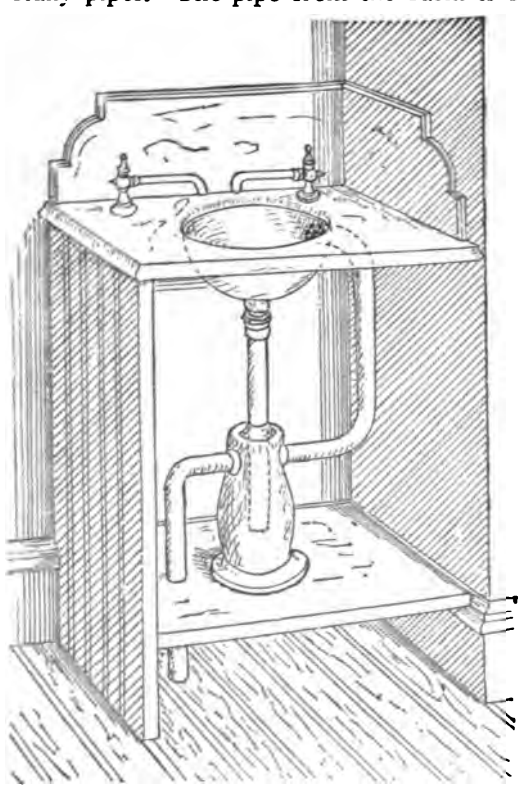


FIGURE 28.

UNRELIABILITY OF HEATED FLUE AS A SUBSTITUTE FOR PROPER TRAPPING.

Q. THE sketch which I send herewith illustrates a job of drainage and ventilation which I did in this city. I would like to have your opinion of the work. The pipe H in the heat-flue is of 4-inch wrought-iron and is completely coated on the inside with sewer-slime, while the other, E, in the middle of the house, is perfectly clean. The work has been in use about two years and a half, and there is not a particle of smell anywhere about the house. I can refer you to the owner, who lives in the house himself.

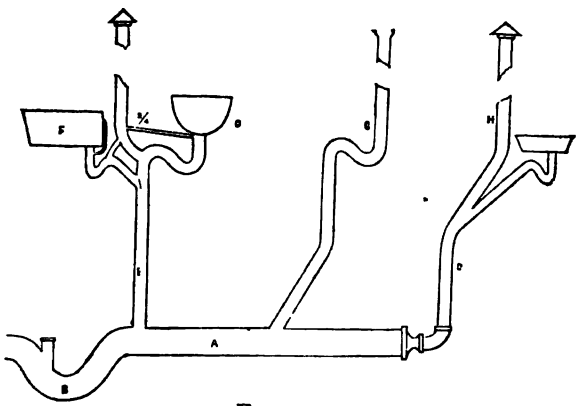


FIGURE 29.

A—Eight-inch terra-cotta pipe in the cellar.
B—Running trap.
C—Rain-water leader, with trap to prevent gas from corroding the leader-pipe.
D—Four-inch pipe to hot chimney.
E—Four-inch pipe.
F—Bath-tub.
G—A pan water-closet, with ¾-inch pipe from the container into the soil-pipe.

A. Judging from your sketch and description, we should say that the absence of any smell during the examination of the premises was due to the fact that such examination was probably made when the chimney was hot and the draught was down the pipe E, and through the pipe H in the chimney. In the absence of a constant heat in the chimney, we think the drain-air would be drawn through the ¾-inch pipe into your water-closet container, and from thence into your house. This pipe practically neutralizes the protection your water-closet trap is intended to afford, and we should advise dispensing with it; also should prefer an iron pipe inside the house to terra-cotta, and one not larger than six inches; in fact, with proper fall and flushing 4-inch is large enough and less likely to get foul.

NEED PLANS IN DOING PLUMBING-WORK.

THE number of cases in which repairs to old plumbing-work have recently been found to result in mischief, by making open roads

around the traps for foul air to enter houses, suggests the need of doing such plumbing-work especially by the aid of carefully-prepared drawings. It is often very difficult to foresee by simple inspection the result that ventilating the traps of old plumbing will lead to. The only safety lies in carefully tracing out the course of the piping as it is, and drawing the modifications on a sheet where the effect can be easily seen. When the alterations have been satisfactorily arranged and sketched the workman should be expected to carefully follow his drawing in making his alterations. We do not at all overstate the necessity for this course, as will appear by consulting the numerous illustrations we have published the last few months. Some of these have been seized upon by the opponents of trap ventilation to bolster up their views, but we think any intelligent reader will see at once that the trouble is not in trap-ventilation, but in the botched way repairs are too often done. Our suggestion aims to substitute careful work for slipshod methods in this important matter.

What we have said of alterations suggests also the great usefulness of preparing working plans for all original work as well. It seems to us that this should be a duty in all plumbing shops. Plans of the piping, position of fixtures, etc., for all work, should be made, and after use filed away for permanent reference. Then any future changes in the work can be made with less trouble and disturbance, and with more certainty and safety. This is a matter which master plumbers should at once give attention to. Modern plumbing has become of too much importance to be done except as all other important works of construction are executed—namely, in accordance with carefully-prepared detailed drawings.

HOUSE-DRAINAGE AND CESSPOOLS

REQUIREMENTS FOR THE DRAINAGE OF EVERY HOUSE.

IN the light of present knowledge, the following seems to us the essential requirements for the drainage of every house. Time and further experience may suggest other features or modifications of these:

A trap should be placed on every main drain, to disconnect the house from the sewer or cesspool.

Every main drain should have an inlet for fresh air,* entering at a point inside the main trap, and carried to a convenient location *out of doors,* not too near windows. In places liable to unusual pressure from the sewer there should be two traps, with a vent-pipe from between them running up full size above the roof; or, where the pressure from sewer is only occasional and the rigor of climate will permit, this vent may be carried to the sidewalk or area, at a safe distance from windows. If the first trap is forced, the gas can gain easier exit through this pipe than through the second trap.

Every vertical soil or waste pipe should be extended at least full size through the roof, preferably increased one size.

No traps should be placed at the foot of vertical soil-pipes to impede circulation.

Traps should be placed under all sinks, basins, baths, wash-trays, water-closets, etc., and as near to these fixtures as practicable.

All traps under fixtures, wherever practicable, should be separately ventilated in order to guard against siphonage.† Such vent-pipes should not branch into a soil-pipe below where any drainage enters it. In some cases it is preferable to carry it to outer air independently.‡

Rain-water leaders should not be used as soil-pipes, and when connected with house-drains they should be made of cast-iron in

*This inlet will relieve the smaller house-traps from pressure occasioned by a descending column of water that would otherwise be likely to force the seals of these traps. The air drawn through this inlet to the lower part of the drainage-system assists the circulation within the drains, and is essential to insure the diffusion of the gases generated within them.

†The extension of soil-pipe, full size, through the roof is not a certain protection against siphonage of traps branching into it, and no protection when traps are on a horizontal pipe a distance from the vertical soil-pipe.

‡And to permit the circulation of air through the drainage system.

preference to galvanized sheet-iron or tin, there being less liability of corrosion. Joints should be gas and water-tight, to preclude possibility of drain-air entering open windows.

No safe-waste should connect with any drain, but it should be carried down independently to a point where its discharge would indicate the existence of a leak or any overflow above.

No waste from a refrigerator should be connected with a drain.

Unless the water-supply is ample, so that it will rise to every part of a building, insuring at all times the proper flushing of fixtures and traps, a cistern should be provided into which the water will rise at night, or into which it may be pumped. Said cistern should be large enough to hold an ample daily supply, be kept clean, covered, and properly ventilated. The overflow-pipe from it should *never* be run into any drain *under any circumstances.* The supply for drinking-water should not be drawn from it, but from a direct supply—*i. e.,* direct from the street-main.

Water-closets should never be supplied directly from street pressure or by a pipe from which branches are taken for drinking-water. Where the valve-closets are preferred to those that are supplied from a small cistern immediately over them, then the supply should be taken to a storage-tank, from which it can be conveyed to the valves on the closets, thereby insuring an equable pressure and securing more reliability in their working.

All drain-pipes within a house should be of *metal* in preference to stoneware, owing to the liability of the latter to crack, and the difficulty of keeping the joints tight. It is best to run them along the cellar-wall or ceiling, with a good incline. They should *never* be hidden underground, as then leaks will not be perceptible. In some places it is common to paint pipes white, so that any leakage will show itself to the most careless observer.

All drains should be kept at all times free from deposit; and if this cannot be effected without flushing, special flushing arrangements should be provided, so as to effectually remove all foul matter from the house-drains to the public sewers.

All horizontal drains should be laid in a straight line, with proper falls, and should be carefully jointed and made water-tight. No right-angled junction should be allowed, except in the case of a drain discharging into a vertical shaft.

No drain should be constructed so as to pass under a dwelling-house, except where absolutely necessary; and then it should be constructed of cast-iron pipes, with lead-calked joints, laid so as to be readily accessible for inspection, and ventilated at each end.

Whenever dampness of site exists, it should be remedied by laying subsoil drains, which should not pass directly to the sewer.

Water-supply and waste pipes should be concentrated as much as possible, and not scattered about a building. Horizontal soil and waste pipes are objectionable.

Plumbing-fixtures should not be hidden behind walls and partitions where their condition is never apparent. They ought properly to be open to view, and so situated that any leak would be readily detected. It is also well to have a plan of the plumbing of each house for the tenants' or owner's convenience and guidance in any emergency.

In planning house-drains they should be got outside the walls of the house as quickly as possible, so that there may be few joints of pipe, and the smallest chance of leakage from defects or accidents, taking precautions in locating to guard against freezing.

DRAINAGE OF A SARATOGA HOUSE.

Q. I AM building a country house at Saratoga, and inclose herein that part of the ground-plan of each floor which is to contain the proposed plumbing, also an elevation.

I have laid a 6-inch drain-pipe, which extends from the house through a sandy soil, at a good decline, some 700 feet, where it empties into the open air, in a low part of my place, from whence it readily flows into a neighboring marsh.

An ample supply of water is furnished by a ram, through a 1-inch supply-pipe, to a tank in the garret, thus giving an abundance of water at all times. The overflow from the tank runs to another large reservoir in the barn.

I desire to have your suggestions in reference to the best mode of connecting the plumbing with the drain and how best to provide for a thorough flushing of the drain without great expense. Also, whether it would not be better to connect the butler's pantry and kitchen sinks with the main drain by an independent drain flowing through a grease-trap; if so, where would you suggest putting the grease-trap, and how would you construct it, and where would you make the connection with the drain?

By referring to the cellar-floor plan, you will notice that it is my intention to connect the main drain with the sewerage-system of the house near the lower water-closet, which is almost under the

slop-sink in the second story, which sink is under the tank, from which it would be possible to create a large flow of water to cleanse the drain. Would the water flowing through an ordinary faucet amount to more than a "driblet" for flushing, or would a larger stream be necessary?

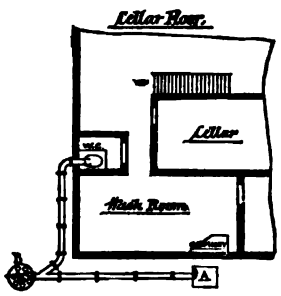


FIGURE 30.

A direct connection between the pantry-sink and the kitchen-sink would be difficult, owing to the chimney which projects into the room, as shown on the plan. Would you advise running a drain separately from each of these sinks straight down to connect with a drain underground on that side of the house? In that case would one large grease-trap be all that would be necessary?

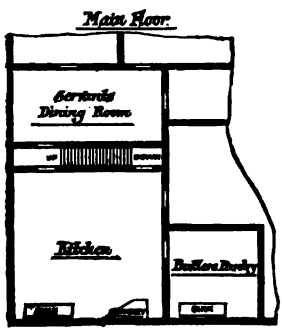


FIGURE 31.

A. There should be a vertical line or "stack" of 4-inch iron soil-pipe leading straight down from the water-closet in the bath-room to the basement story, and also up through the roof. In the basement story there should be in this pipe, directly under the ceiling, a ⅛ bend and a Y-branch with a clearing screw in the other hub of the Y. Thence the pipe can be suspended to the ceiling or attached to the partitions and pass with a good slope to the neighborhood of the water-closet in the basement story. Here three Y-branches should be inserted at suitable places, though two can be combined in one if convenient, to secure the drainage of the water-closet by a 4-inch Y, and the drainage of the slop-sink by a 4 x 2-inch Y, and the waste of the wash-tray by another 4 x 2-inch Y. The pipe can then pass out through the foundation-wall and some two feet beyond it, all of iron. Beyond this the pipe can be of 4-inch stoneware, with a Y-branch, to receive the overflow of the grease-collector, of the same size. The main trap, with its open T-branch, for the air-hole just above it, can be placed close below this junction, and should be

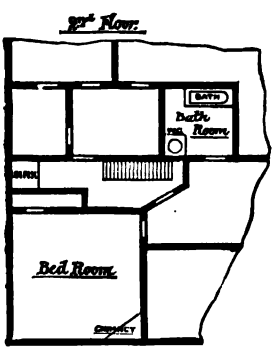


FIGURE 32.

surrounded by a manhole, for getting access to it at any time. If possible, let the trap be at least six inches below the drain discharging into it, so the sewage will fall into the trap from above. It is also a good plan to lead a rain-spout into it by an open connection.

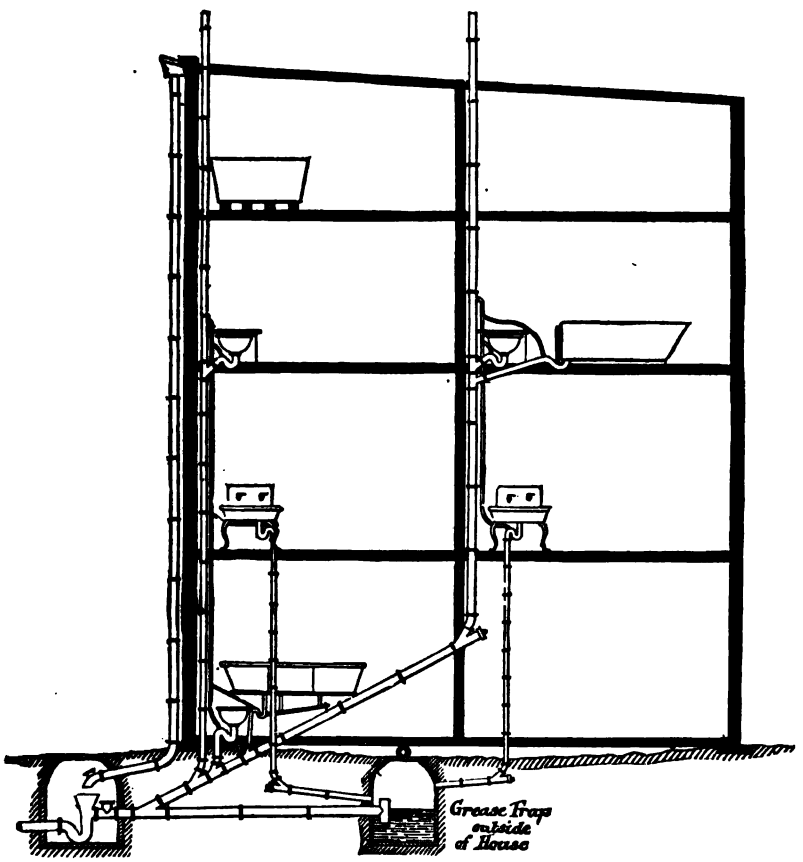


FIGURE 33.

The branch-waste from the slop-sink should extend up through the roof, and should not be less than two inches in diameter above the roof and for two feet below it, though it should be larger, as hereafter explained, if the flush-tank is located in attic. The branch from the wash-trays may be 1½-inch if of lead or 2-inch if of iron.

The waste-pipes from the kitchen-sink and butler's pantry should pass straight down to the basement story, and be provided with clearing screws, where they turn to discharge into the grease-basin. This should be outside and back of the chimney. It should be built of brick, and the overflow from it can be earthenware pipe, with its intake orifice at least six inches under water and joining the main drain just above its trap, as above described, opposite the corner of the house. But if the outlet be a T instead of a bend, it will be more readily cleaned out from above.

Of course, separate traps must be provided for the slop-sink, the bath-tub, the wash-trays, and the kitchen sink, and for the butler's sink, and any other fixtures that may be provided.

The air-pipes from the traps at the cellar water-closet and the wash-trays and sinks over them can all join into one and connect with the air-pipe above waste of slop-sink, where a branch should be inserted for the purpose.

The air-pipes from the traps under the butler's pantry-sink and traps, and under the bath-tub and chamber water-closet, can also be combined and branch into the upper part of soil-pipe just above the water-closet trap.

Your proposed method of disposing of your house-drainage will inevitably make a nuisance in the "marsh." It would be better to distribute it on a field of grass, if you have one, where the ground would not become sodden and saturated with the water. But if you allow it to run in one place as it comes from the house it will certainly make a nasty place of it.

If you have a good fall, as we understand, it would be a good plan to make the discharge intermittent by building a small tank, to be discharged when it is full by some automatic arrangement just below the outside trap. Field's siphon will work well if applied with the clean water that overflows from the house-tank, and can thus be made to flush the whole drain below. The barn can be supplied by a part of this, and the rest used for flushing. The flush-tank can be placed in the attic alongside the supply-tank, if convenient, and thus flush the drain inside the house as well as outside.

In this case a 3-inch vertical pipe should be provided for the flushing, and it can receive the drainage of the slop-sink on the chamber-floor, and extend up through the roof. A flushing-tank of this sort should not be less than some fifty gallons capacity and the siphon not less than three inches.

No constant flow of water from a faucet will flush your drains. This can only be done by a sudden discharge of one or two barrels at once by a flush-tank, as we now recommend.

THE PROPER WAY TO LAY STONEWARE DRAINS

PIPES made of stoneware were used extensively in ancient Rome as water-conduits, and were introduced in this country over twenty-five years ago for drains. After a few years of experimental use, the advantages of the material over the old style of brick-drains were so obvious, and their cost so much less, that their manufacture and use has increased enormously. They have almost entirely superseded the use of brick. When properly made and put together no material is so good for drains, where buried in the ground outside of buildings. Their surfaces are indestructible for all ordinary service, only yielding to strong acids, such as may proceed from chemical laboratories or some kinds of manufacturing refuse. But the notion is very prevalent that any mason's tender who has begun to aspire to the use of the trowel can put them together well enough, and the result has been the wretched botching of by far the greater part of all the drains which have been laid in this material.

The natural result of this bad workmanship is the preference shown by the New York Board of Health, and other similar authorities for iron pipes. The latter are generally put together with lead by plumbers, and these being also made in longer pieces than the stoneware pipes there is less chance of leakage at the joints. But iron is easily corroded, and it would be far better, provided good workmanship could be secured, to use the more imperishable material for all out-of-door drains, which after covering are necessarily difficult of access for repairs.

After many years of experimenting I have arrived at the conclusion that all stoneware pipes should be laid by none but first-class workmen, and even then the work should be tested by slight hydraulic pressure before it is buried deeply, so that defective joints can be readily seen and made good before filling up the trench.

The following specifications describe the method pursued in the sewerage of Princeton College and other places, which, if faithfully carried out, will insure satisfactory work:

SPECIFICATIONS FOR LAYING STONEWARE DRAINS.

Materials.—No pipes should be used which are not nearly cylindrical, a variation of over one-fourth of an inch in the different diameters of a 6-inch pipe being enough to condemn it.

The pipes should not have bells or hubs attached, as is now generally done, but should be formed in simple cylinders, the joints being covered by loose rings or collars of the same material, without glazing, to be broken in three or more pieces when applied.

The thickness should be uniform and not less than ⅝ and ¾-inch for 5-inch and 6-inch pipe, respectively.

The glazing should be *"salt glazing,"* and not *"slip"* or *clay* glazing, and should extend throughout the whole exterior, but should be omitted on the collars and on the outside of pipes for one and one-half inches at either end of the pieces. If the ends are glazed outside the cement used at the joints does not adhere well, and the joint may be leaky, even with good cement and put together with the best of care.

The clay of which they are made should, of course, be of good quality and well burned. Less trouble, however, is found in practice with the kind of clay than with the results of careless molding, such as oval, crooked pipes, with glazing applied all over the ends, for no better reason than because it costs some trouble to omit the glazing there, although it is a positive injury.

The cement should be of any good brand, of fair hydraulic properties, fine and freshly ground, and carefully mixed with not over its own bulk of *clean, sharp* sand. In all places where the sand is not clean (it should not soil the hands when rubbed between them) it should be washed thoroughly in a bed not over six inches deep with a copious flow of water, stirring the sand and water quickly with a hoe and allowing all the loam and clay to be carried off till the water ceases to look muddy. The sand should then be dried and mixed thoroughly with the cement before applying any water. When wetting it for use, no more water should be used than is absolutely necessary to render the motar plastic.

It should be wetted only in small quantities for immediate use. All lots left over an interval of half an hour, long enough to stiffen and begin to "set," should be thrown away and not "tempered up" as is generally done for indiscriminate use. Cement when rewetted after a partial set is sure to shrink and crack when it hardens, and is worthless for pipe-laying.

The ends of pipes and insides of collars should be wetted in warm weather before applying the mortar to these surfaces. If applied dry, the porous pipe absorbs the water so quickly from the mortar that it never hardens properly, and does not adhere to the pipe.

Workmanship.—Pipe should be laid with such good alignment that the inspector can see through every section, like a gun-barrel, from one manhole or lamp hole to another, or from house to sewer. This can readily be done with very little extra cost, if pains be taken to pursue proper methods.

Every piece of pipe should be bedded in cement mortar through its middle portion as well as at its ends, leaving no voids longer than the inside diameter of the pipe between these bearings. The lower half of the pipe should be carefully aligned with its neighbor, by applying to straight-edge inside when bedding, to avoid offset at the joints, leaving slight inaccuracies in form to be developed at the top of the pipe, which is rarely wetted by the flow.

Through every piece of pipe as laid should be passed a cord, made fast where starting, and extending through every section of pipe laid, by means of which a wiper, or rubber disk between two smaller wooden ones, can be pulled through the whole section before leaving it for a night. Of course, the mason is expected to see that every joint is clean as laid, but human nature is fallible, and cannot be trusted to remember this, the consequence of such neglect being often a total failure of the drain.

Every section should be covered about three inches with fine earth, and tested by some two or three feet of water-pressure, when the defects will be seen, and may be remedied before filling the trench. The best masons will be astonished to see how many leaky joints they make unawares, and which may never be detected in any way but this.

The back-filling should be applied with care, packing the material around the pipes without moving them on their beds even a hair's breadth. The trench may be puddled with water if it is at hand, taking care not to wash the cement when applying it.

No good drain can be laid on a yielding foundation. No matter what the material may be, it will break and make leaks when settlement occurs, for though the drain itself is light, the material over it is heavy, and crowds it down as it settles. All drains on newly-filled land should be treated as temporary works, to be replaced when the settlement is finished.

There may be places where the difficulty of getting proper workmanship and proper materials will render it advisable to use iron pipe between the house and sewer, and New York and Brooklyn may be such places; but wherever it is used, it is subject to corrosion, and becomes so incrusted with tubercles inside, after a score of years, that it cannot serve as a self-cleansing sewer. It is necessarily always foul when incumbered with rust, for the flow of water does not cleanse it. It is then a sewer of deposit, open to all the objections that attach to cesspools or other foul sewers.

When used inside of houses it is accessible, and can therefore be readily inspected, both inside and outside, and readily repaired or replaced in case of need. But if buried in the ground, it is out of sight and out of mind, and should therefore be made of imperishable materials.

THE TIGHTNESS OF TILE-DRAINS.

Q. In laying some tile recently we came in contact with several small springs in line of the trench, which tile empties into the bed of a rapid mountain stream. There are springs walled in on both sides of the stream above, within 200 yards of where the tile was laid.

Some days after the work was done water began running from the inside. There has been no connection with any fixtures. The tile was good vitrified drain-tile, laid in cement, each joint being carefully made.

Perhaps it would be well to state that the above is to convey the waste from a bath-house containing nineteen tubs, two closets, one swimming bath, and a few bowls. Is it not *probable* that some of the tile is not thoroughly glazed and allows seepage? Also, please state if you consider it detrimental or objectionable to leave it as it is. Water turned in from the upper end of the waste passes off promptly and *perfectly* free.

A. We should not consider the probability of the water soaking through imperfect glazing so great as that of its coming through imperfectly-closed *joints*. Few masons who put pipe together are aware how difficult a thing it is to insure the tightness of all the joints. Whenever a test is applied the number of leaks developed is astonishing.

If imperfections in the glazing exist to a sufficient extent to account for the flow above reported, they will be likely to be silted up and stop the flow after a few months. We would advise having your pipe tested by applying a tight rubber plug at the lower end, and

filling it with water. If any bad joints exist they can be found readily in this way. Of course, there should not be much earth filled over the pipe where such a test is made. Leaks often occur by breaking down the pipe and splitting the bells or hubs open with the load of the trench-filling, for lack of good continuous bearings. The pipe should be bedded in cement the whole length of every piece, to insure good support.

The objections to using a leaky pipe for drainage are these—viz.: Whenever a dry time occurs the sewage will flow out through the leaks and pollute the soil. The importance of such pollution is entirely a local question. Moreover, the escape of the more fluid parts of the sewage through leaks would, perhaps, lead to trouble for lack of flushing the inside of the drain-pipe, and allow it to accumulate solid matter.

MAKING ADDITIONS TO PLUMBING SYSTEMS.

BY J. D. V.

The trade will be interested in an account of a plumbing system which arrived at completion only after having been worked upon by three different contractors. Figure 34 is a plan showing the location of a fine residence on a prominent avenue in a large city, with a barn in the rear and the cesspool and sewer in front. When originally built there was no sewer in the street, which has since been provided, as shown. This necessitated a cesspool in order that the owner might enjoy the use of sanitary conveniences. A few years after this portion of the work had been done the sewer was laid in the street and the sewer contractor was employed to connect the drainage system of the house with the sewer, which was done in a manner which was not discovered for a considerable time. Figure 35 is an elevation showing how the sewer connection was made. The top of the cesspool was 4 feet below the surface of the ground, and the cesspool was 5 feet in diameter and 12 feet deep. When the drain from the house was connected with the cesspool no trap was provided at the front wall nor was there a fresh-air inlet. The sewer contractor evidently knew that a running trap should be provided to prevent the gases or air from the sewer entering the house system, but as the ground was somewhat rocky he failed to make a gradual fall from the house to the sewer, and missed his calculation as to the level of the house drain at the cesspool, and on reach-

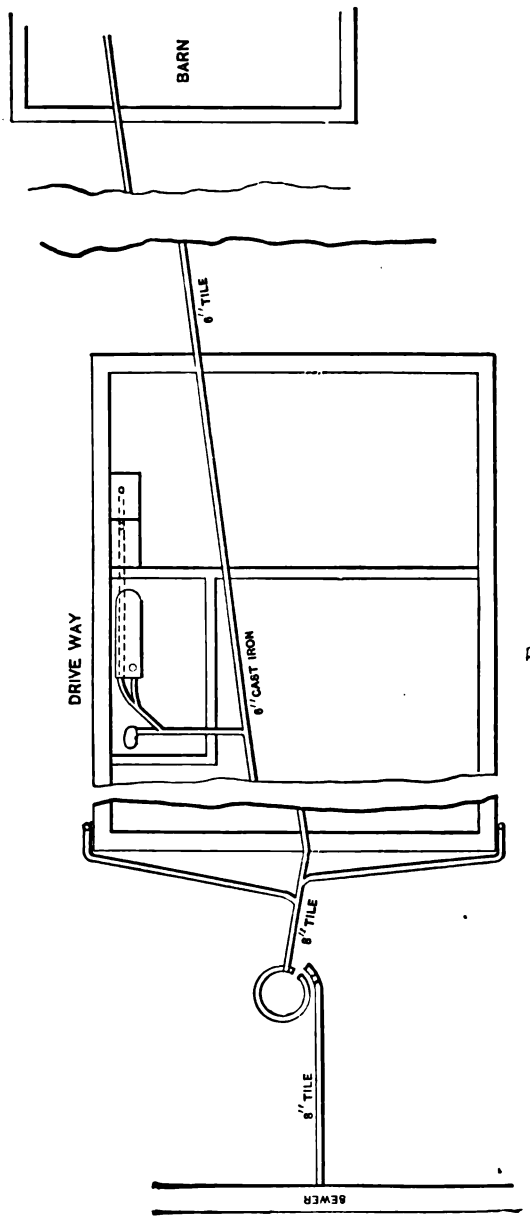


FIGURE 34.

Making Additions to Plumbing Systems.—Showing the Plan of the Part Described.

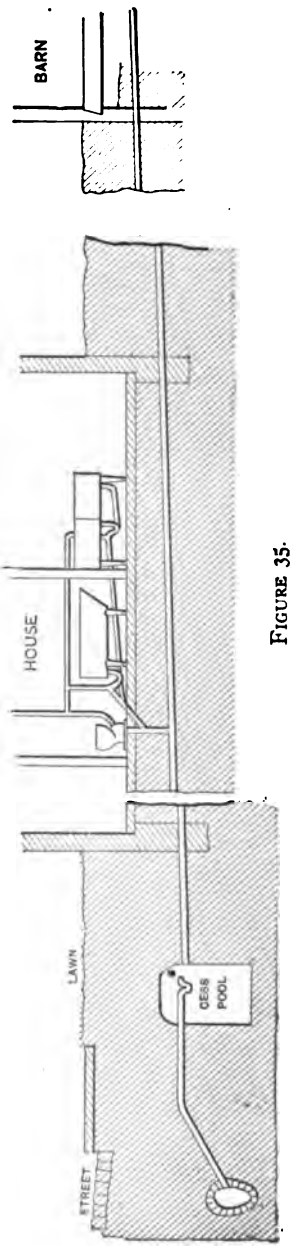


FIGURE 35.

An Elevation Showing How the Cesspool was Connected with the Sewer.

ing that point was 6 inches higher with his pipe than the pipe from the house. Consequently, to connect the house drain direct would entail some labor and expense. He therefore left the house drain connected with the cesspool and, instead of connecting the new drain direct with the cesspool, he placed a running trap, as shown in Figures 34 and 35, and cut an opening in the cesspool so that its contents could flow out, and to aid their finding a way to the running trap, which was left with its end open, a long flat stone was placed below the running trap and one end brought over to the opening in the cesspool. In order to prevent the earth caving in and stopping the opening another flat stone was placed a few inches above the opening of the trap and supported in position by other stones. There being no one to inspect the work, and the owner being absent, the connection, if such it may be called, was left in this condition.

In the meantime, the owner built a barn on the back end of his premises, and the drain was brought from the barn and connected with the house drain at the rear, running the gas pipe for lighting the barn and the service pipe to supply the water in the same trench. With the additional water and sludge from the barn trouble commenced to be experienced at the water-closet in the basement. Frequently in discharging the bathtub or a fixture on the upper floor, the contents of the drain pipe would rise in the water-closet and sometimes in the bathtub.

About this time the owner employed me to rearrange the plumbing in his house, which I did in a manner very similar to that required by the plumbing regulations of New York City, which are supposed to be up-to-date in every respect. The owner told me that the main drains needed no attention, so that they received none at my hands. Shortly after my work was completed the troubles which had caused the rearrangement of the plumbing in the house were repeated. The owner then desired me to make a test of the system. This I refused to do unless I could be satisfied that there was an intercepting trap on the main drain at the front of the house. At that time I did not know of the cesspool, and supposed that the house was connected directly with the sewer. Not finding the trap at the front wall, I traced the pipe to the cesspool and found that it was connected with it. Supposing that an outlet was provided for the cesspool on the opposite side, or that the pipe ran through the cesspool, I dug down to find it, and was somewhat surprised at

finding no pipe on the opposite side. I continued to dig until I found the conditions described above. The earth around the outlet from the cesspool and the running trap was saturated and in a filthy condition.

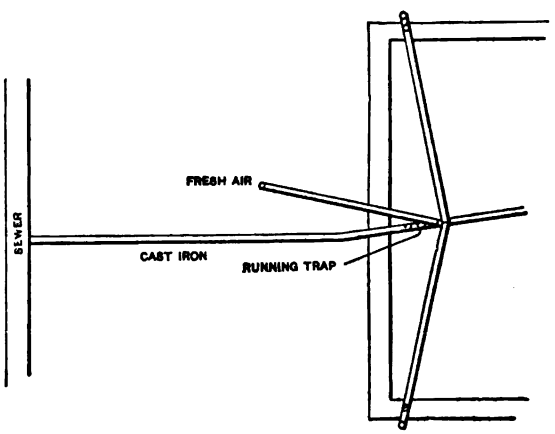


FIGURE 36.
Plan as Now Arranged.

On explaining what I had found to the owner I was ordered to make the changes shown in Figure 36, which is a plan, and Figure 37, which is an elevation, after satisfying him that they were necessary. I filled up the cesspool entirely, so that it can make no trouble in the future; and ran the drain from the house with extra heavy cast-iron pipe throughout, where previously it had been tile. Just inside the front wall and below the cellar floor I put a running trap with a hand hole at each side, and inside of the trap I connected the fresh-air inlet, which I brought to the surface of the ground on the lawn about 10 feet from the house. In doing away with the tile pipe at the front of the house the leaders from the roof were disconnected, owing to the fact that they could not be readily connected with the cast-iron pipe which I had used and the defective condition in which they were found. Just inside of the connection for the fresh-air inlet I connected a sanitary T-Y, and to that a

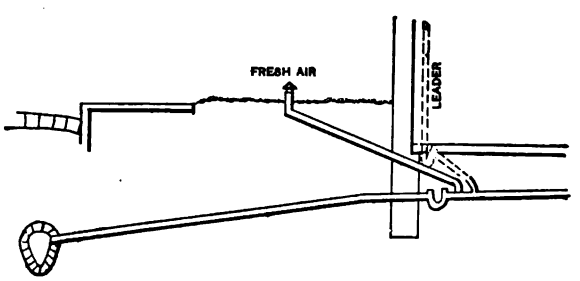


FIGURE 37.
Elevation Showing Changes.

Y, from which I ran branches to the leaders at both sides of the house. At the foot of these leaders I placed running traps with a hand hole, so that they can be readily cleaned out. Since this work has been completed no trouble has been experienced from sewage backing up in the water-closet in the basement or from any stench at any fixture. Since the time when the original work was done it has become necessary for plumbers to file a plan of all work which they propose doing with the proper official, and leave all drains, whether in the house or outside of it, uncovered until they can be inspected by the plumbing inspector.

GROUND-WATER DRAINAGE OF A COUNTRY HOUSE.

Q. WILL you please illustrate the proper way to drain cellars, and the manner of connecting with the main drain leading to the sewer? What precautions should be used to prevent sewer-gas backing into the cellar, presuming that water passes from the cellar into the drain only during fall and spring—cellar being dry during summer and winter?

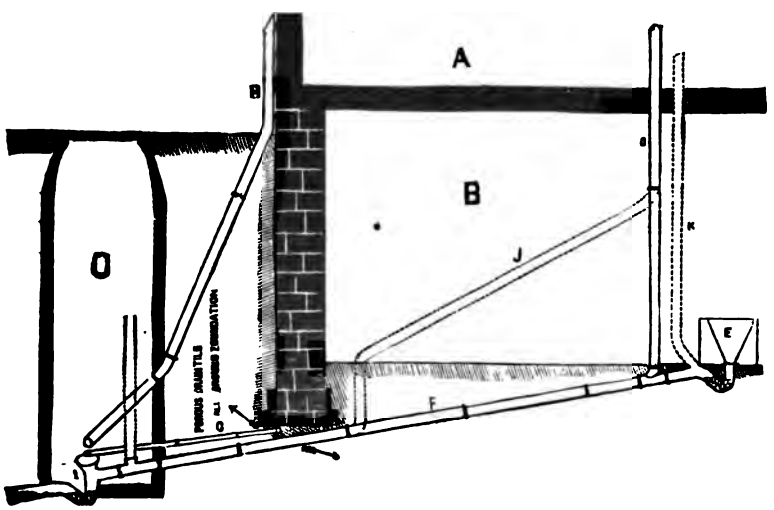


FIGURE 38.

A. The annexed cut shows how the ground-drainage can be delivered to the house-drain with little risk. It is supposed that the building stands by itself, and the ground-drain is to be laid

quite around the foundation of the house. If so, it will effectually cut off all water that might otherwise make the cellar damp. It is also supposed that the soil-pipe extends up through the roof in all cases. This insures an *inward* draught at the vent-hole where the ground-water is admitted, so that the air from inside the house-drain is not likely to follow the ground-drain, which has no vent at its upper end. If rain-water is admitted into the trap as here shown, it keeps the trap flushed occasionally, and it is then better to provide an extra air-hole by a T-branch just above, as shown, so that the air-draught need not be in any way obstructed by a rapid influx of rain-water, as it otherwise might be.

If drainage-fixtures are needed on the level of the cellar-floor, the pipe draining them is laid below that level, as here shown; it should then be kept accessible by building dwarf-walls each side of it up to the level of the floor of cellar, where the trench can be covered with planks or flags of stone, so fitted as to be readily lifted, and not spiked or cemented down. If no water-closets, sinks, or similar fixtures are needed on the cellar-floor it is better to keep the pipe above that level, as shown by the dotted lines.

GROUND-WATER DRAINAGE OF A CITY HOUSE.

WHERE houses are built in continuous blocks, as in cities, the arrangement shown on the accompanying plan is appropriate. In this case the pipe under the basement or subcellar-floor should be of unglazed tiles, laid without mortar of any kind, so that the ground-water can get in at any point, and as it is not a tight drain, but a porous one, for clean water only, it need not be made easy of access, but can be buried. In case a water-closet or other receptacle of foul drainage is needed at this low level, another pipe of iron must be supplied as shown in Figure 38.

Some people connect the ground-drain under the water-seal of the outer trap, but it is not so good a plan as the one shown in the cut, for the following reason: In that case the trap-water sets back into the ground-drain and stands there without circulation, except at such rare intervals as the ground-drain is in active use. This occurs so seldom that the opening where it discharges into the trap is liable to get closed up by fæcal matter and other substances which pass by

the orifice, and the ground-drain has generally insufficient fall to enable its contents to crowd through such a pasty plug and clean itself. The longer this plug remains the more compact it becomes. Of course if the ground-drain discharges in the open air, as shown in Figure 38, this trouble is avoided. During the winter season, and as long as houses are heated by fires, there is always an inward pressure of air at all cracks and orifices near the basement, and the air which is in these ground-drains will at such times press upward through any pores and channels that can be found in the cellar-floor, gradually and surely working its way into the house. The ground-drain is deeply covered and inaccessible, so that if by any chance it becomes defiled by sewage it is next to impossible to clean it. It is, therefore, *very* important that these ground-drains should be kept

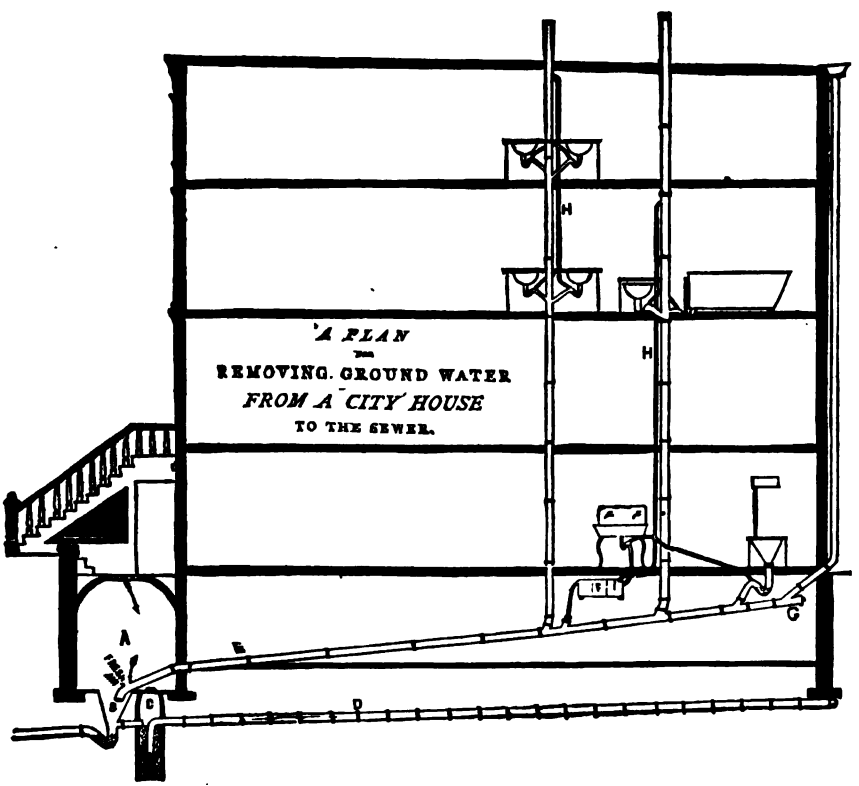


FIGURE 39.

quite free from any possible contamination where connecting with the sewage-drain.

It is generally advisable to put the ground-drains as deep as two or three feet below the cellar floor wherever an outlet can be found at such a level, and this generally precludes the possibility of getting much fall where these ground-drains enter the main house-drain.

In consequence of this condition of things, a very slight obstruction in the house-drain trap, such as may happen from the deposit of a bit of cloth, a broken tea-cup or tumbler in any water-closet above, by a servant who thinks water-closets are made to hide such things, would serve to back up all the sewage of the house into the ground-drain, if care is not taken to prevent such an event.

If arranged as shown in Figure 39, a stoppage in the main trap would cause an overflow in the manhole, which should be inspected frequently and can be cleaned out when occasion requires. But if, as may often happen, it is not possible to get fall enough to prevent such a stoppage backing up the sewage into the ground-drain, some special safeguard must be applied in the shape of a mechanical valve. Such valves are not to be generally recommended in pipes where sewage flows, but this ground-drain is supposed to carry nothing but clean water. Under such conditions a valve may answer a good purpose. Metal valves, and even brass ones, are subject to corrosion, which would seal them fast to their seats if not often lifted.

A good form for this place is a rubber ball-valve arranged as in Bower's trap. But the trap should be specially constructed for this purpose, with a seal of at least twelve inches depth. The clearing-screw should of course be on top instead of at the bottom in this case, and should be examined for removal of sand or silt which the water may possibly bring in, especially during the first flow after the drain is constructed. The space around this trap where the water enters it should be well grouted with hydraulic-cement to prevent any back flow outside the pipe, in case of obstruction of sewage, while the valve in the trap will prevent it on the inside. Such a trap in such a position will hold its water for years, but *should be inspected at least twice a year, because it is of great importance to keep it free from sand and supplied with water.*

If the connection with the main drain were to be made beyond the trap in the latter, we should lose the additional safeguard of that trap against the admission of sewer-air, which safeguard it is best to retain.

FLUSHING AND CLEANING SMALL TERRA COTTA SEWERS.

BY J. N. S.

THERE are numerous cities throughout the country in which the majority of the streets or avenues are reserved for private residences, and where the rain-water leaders of the residences cannot be connected to the house-drain, for the reason that the sewer in the street would be too small to carry off both the rain water and the waste from the drain pipes of the residences. Since the rain water is not allowed to empty into the sewers to help in keeping them flushed, some other method must be adopted. The lateral sewers are quite often not larger than 8 inches in diameter and are made of salt glazed terra cotta pipe.

In places where a good fall can be given the pipe and where there is an abundant water supply, the fire hydrant can be used to flush the sewer by connecting a line of fire hose to a hydrant convenient to a manhole situated at a high point on the line of sewer. The other end of the fire hose is lowered down the manhole and shoved well into the pipe. The water is gradually turned on until the full head of water rushes into the sewer, thus washing away all deposits which may have accumulated in the pipe. It not only helps to flush the sewer but also blows out the water main occasionally.

Should the grade of the sewer not be so rapid and possibly the water supply not so abundant, automatic contrivances must be used for flushing, such as automatic flush tanks. These tanks must be constructed at a high point on the line of sewer and they are usually made of brick cemented inside and outside to make them water tight. They ordinarily have a capacity of about 200 gallons of water, but can be made to hold more or less, according to the needs of the sewer. A tank can be so regulated that it will discharge its full contents into the sewer at least once in every 24 hours, or twice, if deemed necessary, by allowing a stream of water to constantly flow into this tank from the water main through a pipe on which is placed a regulating cock to control the supply of water to the requirements of the tank.

This tank must be below frost and have a suitable cover perforated so that air can be admitted and also expelled, and it is dis-

charged by means of a siphon. Different devices are used to make the siphon work; but as all siphons consist of a short and long leg it may be annular in form, or of the return pattern. The short leg reaches very nearly to the bottom of the tank, with the long leg extending down to a tilting device, or else a weir-like contrivance, which, in turn, must empty directly into the sewer. The bottom of the long leg must be sealed at the beginning of the discharge and unsealed at the conclusion. As the water rises up in the tank it expels the air which is in the short leg until it starts to fall down in the long leg, thus sealing the bottom of the pipe for about 1 inch in depth. As the water drops down it carries the air with it until a partial vacuum is secured when the siphon will begin to work. The tilting tank will then drop, and remain so until the siphonage is complete, when air will rush in, the tilting tank drop back into position, and the tank proper be restored to its normal condition. On the other hand the weir will be siphoned out through a pipe specially arranged for this purpose, also restoring an equilibrium. Sewers

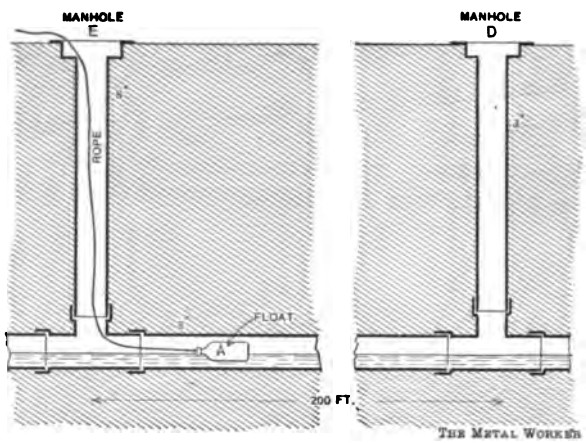


FIGURE 40.

Flushing and Cleaning Small Terra Cotta Sewers. Floating a Line Down to Draw Cleaner.

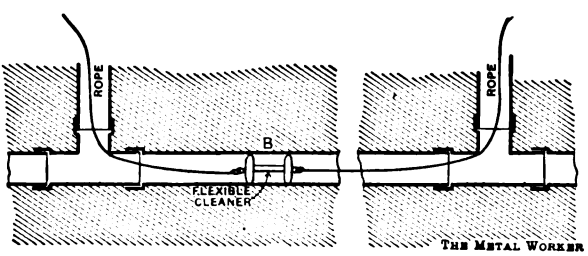


FIGURE 41.

Flexible Cleaner in Use.

which are cleansed by this method can never become foul, and in consequence the intercepting trap can be dispensed with.

To thoroughly cleanse or flush a sewer, it should be filled with water its entire length, if it is possible to do so, so that the higher as well as the lower part would be full. It would draw in fresh air in proportion to the amount of water held in check, and upon its sudden discharge would ventilate the sewer. But should the topography of the locality not permit of a good fall being given to the sewer pipe, on account of the land being of a flat or nearly level nature and where none of the former methods could be used to advantage, then cleaners must be relied on to keep the sewage free from filth.

At every 100 or 200 feet a manhole or access hole is constructed to permit of a line being dropped down in the sewer on the end of which is a float. This floats with the current until it reaches the next manhole. It is then caught and a stronger line is drawn through, on which a cleaner is firmly secured. This cleaner is the full size of the pipe. It is pliable, for if it were too rigid it would be apt to get wedged and cause endless trouble. As this cleaner is pulled through it holds back the water in the sewer until the pipe is full. It is then suddenly pulled out at the lower end. It scrapes off all the grease or other filthy matter which adheres to the pipe, which the water will wash away. Anything which will not float away is caught and brought up to the surface.

I present a sketch which I hope will explain how the operation is performed. This is continued from manhole to manhole until the entire line of sewer is cleaned, and so on from street to street, by men who are constantly employed for this class of work. In Figure 40 is shown the line with float, and at B is the flexible cleaner. E is the upper manhole and D the lower one.

The house drain may be 4, 5 or 6 inches in diameter, as the case may be; but it is argued by eminent engineers that a pipe 4 inches in diameter is fully capable of carrying off the sewage from the majority of private houses. As nothing but the liquid or semiliquid waste is supposed to pass through those house drains, it will have a better chance to cleanse itself, from the fact that the fuller this pipe will run at every discharge the better chance it has to flush itself. Some of the houses may be located as far back as 50 feet from the sidewalk line, which would require a long stretch of pipe in order to connect the house with the sewer.

The following method is used in some cities to determine the course in which this house pipe was laid so as to locate it in case that there should ever be an obstruction in it: A lamp hole is placed on the pipe on a direct line with the pipe coming through the front wall and usually about 1 foot inside the property line at the front. It consists of a tee placed in the line of pipe with the side connection facing upward. The pipe is extended vertically up to the surface of the ground and the top finished with a suitable cover. When there is an obstruction this cover can be removed, and should the obstruction be in the street water will stand well up in this pipe. If not, then the obstruction is nearer to the house.

If there are no provisions in the house to permit the rodding of the drain and should the pipe be underground, the lamp hole or guide pipe will enable the plumber to know where to dig. The pipe can then be tapped and cleaned. If the obstruction is in the street, the lamp hole will serve as a guide for digging down to the sewer so that it can be rodded, providing there are no broken pipes. The pipe between the house and the lamp hole could also be rodded out if it were found necessary to do so. Such a system of marking the drain saves useless digging, saves the lawn from being destroyed and is always a sure indication as to how the pipe has been laid.

The rain water leaders must be carried out to the curb stone in a separate pipe a little way under ground, a hole being cut in the curb stone to allow the rain water to flow into the gutter, or else it may be allowed to flow out on the surface of the ground and get away as best it can, the gutter being graded to a storm inlet. This inlet may empty into the same sewer in which the lateral sewers also empty, or else into a separate pipe which would be constructed for that purpose. Very often the street can be graded to an adjacent stream. When this is possible all storm water can be allowed to flow away by this means.

BUILDING A CESSPOOL.

Q. We take the liberty of asking for information on the construction of cesspools for closets where there are no sewers. We are informed that there is a system whereby the liquids are carried off through a series of drains and absorbed by the earth and solids retained in the cesspool. We particularly wish to know how the

cesspool is formed to retain solids and allow liquids to be drawn off. What depth it should be in the ground, how ventilated, if at all, whether soil pipe should be trapped as in connecting into a sewer, or should the piping allow the current to pass up through the house and out at the roof? We understand that trapping and venting must be done within the building, just the same as if emptying into a sewer.

A. Laws are made to restrict the use of cesspools in all thickly settled districts and in cities. It is unfortunate that a system of sewers does not precede or become adopted and laid at the same time that a system of water supply is arranged. More water is always used in buildings where it is to be had by opening a faucet. Consequently there is more waste to be disposed of, and the use of modern water-closets, lavatories and baths still further increases the waste. The disposal of this waste is a subject that has been given a great deal of study, and the best cesspool is regarded with little favor and its adoption should only be decided upon after a careful consideration of the possible evils that may arise from it. The stench that it occasionally gives rise to is least objectionable, as it is apparent, but the gases that are given off are frequently of a dangerous character, showing clearly that a cesspool should be located at as great a distance as possible from all buildings. Though there is water supply in the town, it is quite possible that a number of wells are still used and the area of ground that will be contaminated by a leeching cesspool should be considered in locating it, and, if the soil has a clay bottom, preventing the liquid from soaking down, a greater space should be given than if the soil is of a sand or gravel nature. If the cesspool is ventilated great care must be observed to keep the outlet of the vent pipe well away from any window so that the air may not enter the building. If a tree is near the cesspool a pipe may be run up near its top. A trap should be placed on the pipe discharging into the cesspool, and a fresh air inlet should be placed on the line of pipe near the trap, but on the side away from the cesspool. Having considered these few of the objections to the use of a cesspool, if one is to be used, the following method of construction is looked upon as having the greatest number of recommendations, and as a help to our correspondent an illustration is given. At the right is a leeching cesspool 6 feet in diameter and 6 feet deep, with the brick or stone making the wall laid without mortar so that the liquids it receives may soak away into the earth. Its top should be a foot or more below the

ground and covered with some material that will support a covering of earth. The earth covering will serve to prevent any stench arising and will largely disinfect the foul air that comes up through it. Ample provision should be made for thoroughly cleaning frequently. Within a few feet of this leeching cesspool a water tight receiver of the same dimensions should be built and covered in the same way, and so ar-

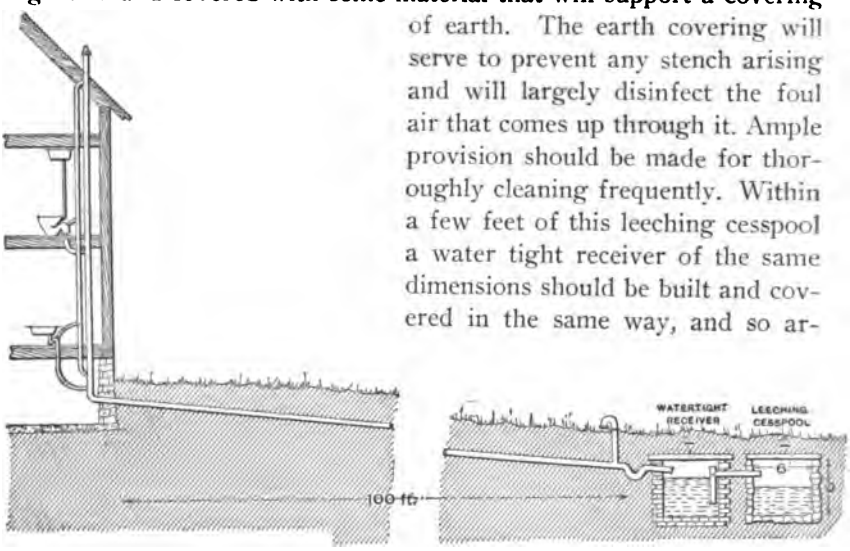


FIGURE 42.

ranged that the accumulated solid matter can be easily removed. The outlet from the receiver to the cesspool should be made by means of a T on the pipe, the top end being open to prevent it becoming air bound, and the bottom end extending down into the receiver so that the floating solids may not escape. At the opposite side of the receiver the soil pipe from the building should enter near the top. A trap should be placed on this pipe just before it enters the receiver and at the side of trap away from the receiver a fresh air inlet should be placed on the pipe. The pipe should be run from the house with a good fall, and should run up through the house above the roof.

FAULTY PLAN OF A CESSPOOL.

Q. WHAT do you think of the following arrangement, to be used as a cesspool where there is a city water-supply but no sewer?

The outer walls to be laid in hydraulic-cement; the central partition to be of brick laid in common mortar, so as to act as a filter; the outlet on the other side of this partition to run the liquid to a pile of loose stones, where it will soak into the soil. Of course, the organic germs will still remain in the liquid after it leaves the cesspool, but will there be enough to do any harm in a place where the water-supply is obtained from the city and the soil is a light sand? The object in this is to save the expense of a cesspool large enough to hold

both the solid and liquid waste of the house for any length of time. The lot will be about 140 feet deep in the rear of the house. A is the inlet from house, B vent, C outlet, and D D apartments separated by a brick wall.

A. This arrangement will not act as intended. First, the partition—which is meant to act as a filter—will have its pores filled tight with solid matter in a few days, and cease to soak water. The contents of the inlet side will then rise and pour over the top of the partition.

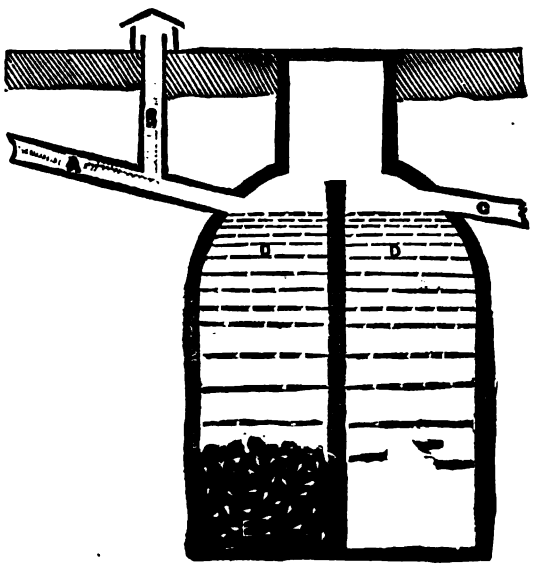


FIGURE 43.

If kitchen-sink drainage is discharged into this receptacle, the grease from dish-washing would soon collect as a scum on the surface and choke the outlet-pipe. The apparatus would act very well as a grease-interceptor if it is close to the house (not otherwise), by making one or more holes in the partition about half way down, by taking out a brick, and attaching a T-branch to the outlet-pipe, so it may take water from a point a foot below the surface, and avoid taking in the floating grease.

As to allowing the tank to overflow into a pile of stones, that will make a nuisance at this point and pollute the soil. The proper method is to distribute the contents of the tank on to the surface of the soil, by dipping it out when filled, or by irrigation-pipes under the surface. It is a mistake to suppose that the fluids of house-drainage are less harmful than the solids so-called. The latter all become fluid or gaseous in a very short time, and do not *settle* to the bottom, as supposed. The only sediment found in such places is composed of the sand used in scouring floors, and such particles of dirt as may adhere to it.

SIZE OF FLUSH-TANK TO DEAL WITH SEWAGE OF A SMALL HOSPITAL.

Q. WHAT should be the dimensions of the flush-tank and settling-basin for disposing of the sewage of a hospital of twenty-five beds by sub-surface irrigation?

A. We should make each about five feet diameter and five feet deep below the water-line, or of equivalent capacity; broader and less deep if more convenient. The storage would then amount to about 750 gallons. There would be needed from 2,000 to 2,500 feet of distributing tiles, depending on the porosity of the soil, the more porous soils needing less pipe than clayey soils. The above is based on the supposition of an abundant water-supply under constant pressure. If water is to be supplied by hand-pumping, half of the above capacity would be ample.

CESSPOOL FOR BATH AND BASIN WASTE-WATER.

Q. As a personal favor, will you tell me if there can be any harm in allowing waste-water from bath and wash-basin to run into an open-side cesspool (covered at top), such cesspool being in gravelly ground? Water-closets and wash-tubs will be connected by a separate pipe to cemented cesspool. House is in the country, and open-side cesspool would be 100 feet from house.

A. Such a cesspool will contaminate the soil about it quite as surely as if receiving the drainage of water-closets, though perhaps not quite so rapidly. It is better to distribute the refuse on or near the surface. A collection of waste-water from bath-tubs and wash-bowls will become as foul as any other refuse from the house, and differs only from other refuse in being diluted by a greater bulk of water.

The disposal of house-sewage in suburban residences is a very troublesome question, especially where a public water-supply is afforded without sewers—a state of things which is not compatible with public safety. Distribution *on* the surface is the simplest method; but this requires at least an acre about every house, in order to make it free from offense.

It can be distributed in porous tiles about ten inches *under* the surface on smaller house-lots if the conditions are favorable—viz., a well-drained or porous soil..

Whether on the surface or beneath it, there must be slope enough to allow the sewage to flow by gravity from the bottom of the cesspool to the place of distribution, otherwise pumping is necessary, which is of course onerous. When distributing in pipes beneath the surface, it is usual to lay 2-inch unglazed tiles, with joints at least one-quarter of an inch open, in trenches ten or twelve inches deep, graded with a uniform fall of not over an inch in ten feet at most, and sometimes not over half this amount. Sufficient ramification and length of pipe must be provided to give a capacity of at least one-half that of the cesspool or tank to be discharged; the other half is generally soaked away during the flow. It is important to secure an intermittent flow in the tiles. If a constant driblet flows into them they will always be choked in a short time. When on a larger scale, as for hotels and public institutions, Field's flush-tank is used with success to secure this periodic or intermittent flow, but it does not operate so well for small cesspools. If the water-supply is limited to what is pumped by hand in the house, the discharge can be made by means of a stop-gate laid in the outlet-pipe leading from the bottom of the cesspool, and operated by hand when required. The tiles adapted for this purpose are readily obtainable.

OBJECTIONS TO LEECHING CESSPOOL AND NEED OF FRESH-AIR INLET.

Q. I HAVE a water-closet on the second floor of a country house, with the soil-pipe carried to the roof and ventilated. The waste runs into a closed cesspool some thirty feet distant, with a trap shutting it off from the house. I should like to ask, first, if it is necessary to have a vent on this trap which would be of necessity only a few feet from the water-closet vent, one just within and the other just without the wall? There is no chance for foot-ventilation, as there is only a grass-plot near by where children play. Second, is there any harm in a covered cesspool, which has never filled up in ten years, but which leeches through a gravelly, sloping soil into a small sewer, with no wells or neighbors to contaminate? There is a dispute about the vents being necessary, and it is hard to decide where doctors disagree. I wish you sanitarians would come to some agreement on certain points, and then we laymen would not so often be nonplussed, and, as it were, liable to fall between two stools.

A. Your waste or drain pipe should be extended to the "small sewer," and not be allowed to contaminate the soil near the house. There should be a vent just inside the outer trap, and there is no

harm in having this open on the front lawn, for the draught is *inward* at this opening and up through roof of house by the soil-pipe. Since the water-closet trap is on the second floor, there must be twelve feet or more between the traps, and even if less, the lawn vent-hole is needed to establish a thorough draught. No sanitarian who is worthy of the name will question the propriety of establishing such a draught.

Secondly—With a cesspool in a gravelly soil only 30 feet from the house, there is great risk of foul gases making their way into the house. As regards differences of opinion, it is as well to remember that not every one is a sanitarian who calls himself such. Amateur counsel in such matters is plentiful, but in the end often terribly expensive.

DRAINAGE INTO CESSPOOLS.

Q. AN architect of this city directs me to you for some information. I am putting two bath-tubs and three wash-basins in my house, and was about to empty them (the waste-water) into a well about 15 feet to the west of my house. Can you let me know a better course? Is there any objection to emptying into this well? If so, what is it?

This, and any information you can give me, will be very thankfully received.

A. If you have no sewer to drain into, a "well" (or cesspool, we presume you mean) must be accepted as a compromise. It should be perfectly water tight, and if it must be as near as 15 feet to your house, it should be tightly covered, with two pipes extending from it, with their open ends above your house, or far enough away to prevent the smell from being disagreeable. The contents should be frequently removed, and great care taken to prevent a nuisance.

WELLS AND CESSPOOLS.

Q. UNDERLYING this valley is a layer of gravel, out of which can be obtained an abundant supply of water by driving only a few feet beneath the surface. How near a driven well could a cesspool be located and be safe?

A. A cesspool and a well make very bad neighbors, and it is hard to give advice that will certainly be safe, unless we recommend that they be put a very great distance apart. The seepage from a

cesspool spreads rapidly in the gravel, and the liquid carries the soluble part of the sewage directly into the subterranean water ways, and will contaminate wells at a long distance in the direction of the water flow. If water in any given area was supplied in some miraculous way from the surface immediately about the well it would be an easy matter to locate a cesspool so that it would not contaminate the well water. Underneath the earth, however, the subterranean water has its ebbs and flows, and travels long distances. Contagion from well water has been traced to the source at a great distance from where the germs have been carried by subterranean streams or courses of water, whose direction has been determined by rock strata or hard pan dipping from a cesspool to a well. The grosser sort of waste will be filtered out, traveling a little way through sand or gravel, but the microscopical disease germs have been known to travel long distance with unimpaired vitality. Cesspools in open soils should be located on the down stream side of a well, if the slope of the land and a neighboring stream indicate the direction. If no indication can be had of the sub-water flow the only safety will be in locating a cesspool as far as possible from the well, and make it tight by a clay or cement lining and depend upon emptying when full. In villages drawing their water from the soil this is the only safe way.

CESSPOOL FOR PRIVY-VAULT.

Q. WOULD there be any special objection to using a water-tight cesspool as a privy? This would insure its ventilation. Would it be likely to be offensive to those obliged to use it? It is 136 feet from any house.

A. We see no objection, except that it might be disagreeable while using it, as suggested; and in frosty weather the frost would collect on the underside of the covers in an annoying manner.

WILL THE CONTENTS OF A CESSPOOL FREEZE?

Q. IN this climate, what is the average temperature of sewage in cold weather? and would an intercepting cesspool be liable to freeze under the following conditions: Cesspool or grease-trap, to intercept the waste of house with eight inmates, to be of 300 gallons capacity, tight, with arch just under surface of ground, a cold, open winter, and the ground over cesspool to be covered with a foot and a half of straw, held down by boards?

A. The average temperature of sewage in winter in this climate (near New York City) is considerably above the freezing point. It could not freeze when in a tight cesspool, protected as above described. Even if the covering of straw were omitted, there would be no frost if the drain were constantly used by a continual flow of water, except a condensation of hoar-frost on the underside of the cover, and possibly a disturbance of the upper courses of the brick-work and plastering near the top of the ground. If, however, ample ventilation were provided by any means which would cause a circulation of cold, frosty air through the interior, the fluids would probably freeze over, and possibly obstruct the pipes by ice in a severe winter.

HOW TO DISINFECT A CESSPOOL.

Q. CAN you tell me any way to get rid of those bugs called Croton bugs, or cockroaches, as they are sometimes called? They seem to appear always where water-pipes are put in, and pay no attention to insect-powder. Also, what is the best means of disinfecting sinks, drains, cesspools, etc.?

A. We have, in several cases, known these "water-bugs" to be exterminated by a sprinkling of powdered borax distributed around the shelves, drawers, etc., where they congregate most.

The best disinfectant for sinks is hot soapsuds, applied with elbow-grease and a scraper.

For drains, the best way is to see that no pockets or places of deposit occur by defective planning or construction, ventilate at both ends, and apply plenty of water. If obstructions occur, remove them at once.

For cesspools, copperas-water is good, but it acts only for the time being. It is a good plan to clean them out often, if you must have them, and apply copperas-water to the sides liberally after such cleanings.

TEST FOR SEWER AIR.

Q. WILL you tell me how I can determine the kind and quantity of gases present in a certain quantity of air? To be more plain, how can I test and show to a person what kind of air he breathes, who

has a poor plumbing job in his house and who makes fun of the danger of sewer gas? I think we ought to know how to analyze sewer gas and tell what it is composed of, if it is possible for us to do so. My idea is to catch the gas over a sink or other fixture, which I know from its arrangement is sending out sewer gas, and subject it to a chemical test and prove to those interested what it contains.

A. This inquiry was submitted to Wm. Paul Gerhard, the well-known sanitary expert, who furnishes the following reply: In answer to your correspondent's question I will first define the words sewer gas, and discuss the composition of the same. The term sewer gas is not a good one, for it leads many to suppose that this is a distinct gaseous substance contained in drains, sewers or cesspools, which when it gains entrance to dwellings mixes with the air of the rooms. It should be clearly understood that there is no such gas as sewer gas. What is usually so termed is merely a continually varying mechanical mixture of a number of gases which originate in the decomposition of organic matter. In other words, the gases are not in a chemical union, but are simply contained, in varying proportions, in the air of soil pipes, drains or sewers; they are mixed up, as it were, with the two principal components of ordinary air—viz., oxygen and nitrogen. The principal gases, forming the mixture, are carbonic dioxide, carbonic oxide, ammonia, carbonate of ammonia, sulphide of ammonium, sulphuretted hydrogen and some hydro-carbons, such as marsh gas. Normal atmospheric air contains, by volume, about 20.9 parts of oxygen, and 79.1 parts of nitrogen. Added to this is a trace of ammonia, and from 2 to 5 parts of carbonic dioxide in every 10,000 parts of air. In the air of sewers the quantity of carbonic dioxide is considerably increased, whereas the oxygen is diminished. Thus, to quote only one chemical analysis of the air of a Paris sewer, the oxygen was 17.4 parts, and the carbonic dioxide 2.3 parts per 100. In some extremely foul sewers the quantity of oxygen was diminished to only 13.99 parts, and in a similar bad sewer as much as 29.9 parts of sulphuretted hydrogen were found.

Nearly all the above ingredients of sewer air are generally present in extremely small quantities. Carbonic oxide, if present, is usually due to the leakage into the sewers of illuminating gas, of which it forms an important element. This, when mixed with a certain quantity of air, gives to sewer air its explosive quality. The same may be said of marsh gas, a gas arising from organic decomposition, which is also found in mines and is the cause of explosions

in them. In general, it should be said that even in sewers of bad construction the air does not differ from the normal standard as much as many suppose.

Doubtless many of the gases named are poisonous if present in large quantities, and even in smaller bulk they cause nausea, headache, vomiting or asphyxia, but none of them can produce any of the zymotic diseases commonly attributed to the inhalation of sewer air. Diluted with plenty of fresh air, as they should be in properly ventilated sewers and house drains, they cannot do much harm. It is now believed that zymotic diseases arise from certain micro-organisms or pathogenic bacteria contained in sewer air; these are without doubt the really hurtful particles. For this reason any escape of sewer air into living or sleeping rooms should be prevented. The escape of any foul air, whether it contains germs or not, is likewise to be guarded against on account of its offensiveness to smell and its general unwholesome effect.*

From what has been said it follows that it is desirable to avoid the use of the term sewer gas, and to substitute for it the words sewer air. It is also apparent that sewer air does not come from street sewers only; on the contrary, much of the foul air is generated in the soil and waste pipes of a house.

As regards the inquiry of your correspondent for a simple test to demonstrate the presence or the escape of sewer air, it should be stated that no such simple test is available. A complete chemical analysis of sewer air can only be carried out by competent chemists, and the tests are obviously impracticable, both for the plumber and the sanitary engineer. Of the various elements composing sewer air, but one—namely, the sulphuretted hydrogen—might be detected by a simple test, provided it were present in a sufficient quantity. This gas has the property of discoloring white lead to a brown color. Therefore a piece of wood or metal might be painted with white lead, and after being held for some time over the place where sewer air is suspected to escape, it might be detected by the brownish discoloration of the paint. This test would, of course, show merely the presence of sulphuretted hydrogen, but would not serve to determine the quantity of the gas. It should be said, however, that such tests

*It may be here remarked that, contrary to the accepted theories prevailing in the United States as well as in England, the German scientists and bacteriologists persistently deny the existence of any proof that sewer air may cause infectious disease, and they cite a number of bacteriological analyses of sewer air, according to which but few pathogenic bacteria are present in such air.—*W. P. G.*

would be of comparatively little practical value. After all the foul gases are not the really dangerous elements of sewer air, and to recognize and detect the germs of disease would require very delicate bacteriological tests, which are entirely beyond the province of plumbers.

Let me suggest to your correspondent a much more simple and practical way to show to his customer the danger of faulty plumbing work. If the plumbing is defective and permits the entrance of sewer air, this must be due either to defective pipes or pipe joints or to defective trapping of fixtures, to overflow pipes wrongly connected or left untrapped, to by-passes in vent pipes, to the loss of the water seal in traps, caused either by siphonage, or by back pressure, or by evaporation, or finally by some capillary attraction in the outer bend of the trap.

If the plumbing is defective in any of these respects let the plumber apply a thorough and intelligently conducted test, for which I should recommend either the peppermint test, or better still, a smoke test. Let him explain to his customer briefly the rationale of the test—*i. e.*, that the volatile oil, or else the smoke of burning tarred paper, is introduced into the soil pipe system from outdoors merely as a test medium, and that of course if there are no leaks or defects there should be no indication of the pungent smell of the oil nor any appearance of smoke anywhere in the house. If the owner is present during the test, to watch the proceedings, he cannot fail to be convinced that his house is in constant danger from sewer air when the smell should appear in any part of the house, or when, as frequently happens where there are bad leaks, the rooms become filled with the smoke.

Perhaps it may be well to mention that if the suspected escape of sewer air is due to the traps becoming unsealed, or in other ways ineffective, these conditions should be established before the test is applied. The plumber should also emphasize the fact that the sense of smell cannot be ordinarily depended upon as regards defects in the plumbing, for the fact that house air is not bad smelling cannot be taken as proof that there is no escape of sewer air into a house.

The smoke test is preferable to the peppermint test because in case of bad defects it locates the defect accurately by the visible escape of smoke, whereas this is not always the case with the odor of peppermint. Several good smoke testing machines are now sold in this country, and I should advise the correspondent, if he does not

already possess such a machine, to purchase one, for it will prove extremely useful to him, not only in detecting bad plumbing and convincing owners of the much needed repairs, but it will likewise prove useful to him after doing new work, in showing to his customer that he has done the work well and that the plumbing job is entirely tight.

VELOCITY OF FLOW IN HOUSE DRAINS.

Q. WILL you kindly give me a simple rule (and also an example) for calculating the velocity of flow in iron house drains of 4, 5 and 6 inch diameter, the fall being from ¼ to 1 inch to the foot?

A. The flow of sewage in inclined house drains varies somewhat with the quantity flowing and also with the nature of the flow, whether constant or as a flush. The fullness of flow in a pipe makes a variable wet perimeter in proportion to the sectional area, which makes a variable exponent in the formula. The slope must be converted into the number of feet per mile, which is the basis of the formula,

$\sqrt{\frac{A}{P} 2 D}$ = velocity in feet per second, and reads square root of the sum of the area in square feet, divided by the wet perimeter of the section, multiplied by twice the slope in feet per mile. The wet perimeter is the part of the internal circumference of the pipe covered by the flowing water.

For example, a 6-inch pipe with a slope of ½ inch per foot, flowing half full: A, area of flowing water = 14 inches, or 0.097 square foot; P, wet perimeter = 9.4 inches, or 0.78 foot; D, slope ½ inch per foot = 220 feet per mile. The equation then, when figured, will be:

$\sqrt{\frac{0.097}{0.78} \times 2 \times 220} = 54.692$, the square root of which is 7.39, the velocity of flow in feet per second.

It will be seen on further computation that water will not flow as fast in a smaller pipe under the same conditions, say a 4-inch pipe flowing half full, with the same slope as the 6-inch pipe. For such a pipe the half area will be 6¼ inches, or 0.0433 square foot, and the wet perimeter will be one-half the circumference = 0.52 foot, and

the slope as before, 220 feet per mile. Then as before

$\sqrt{\frac{0.0433}{0.52}} \times 2 \times 220 = \sqrt{36.6} = 6.05$ feet per second velocity of flow. It will be seen from computation of the conditions for various sizes that the slope should be nearly inversely as the size of the pipe for equal velocities of flow and for any flow section of the pipes.

FRESH-AIR INLETS.

FOUL AIR FROM FRESH-AIR INLETS.

Q. I HAVE read several articles recently wherein I see that, like myself, there are a great many plumbers who don't approve of the running-trap placed in the main sewer-pipe, and connected with fresh-air inlet on house side of trap, which seems to be the plan most generally adopted by most of your contributors.

I contend that when the pipe is flushed by a large discharge of water from slop-sink or other fixture, there will be a quantity of foul air discharged from the fresh-air inlet contaminated from contact with foul matter adhering to the inside of pipes, and likely to be carried back into the house through an open window or door. And then what would be the result? Another plumber would be sent for; he would condemn, or the house-owner would insist on its immediate stoppage. The trap it is likely they would let remain; then the discharge through the larger traps, not having free passage to sewer or cesspool, would overcome the water in smaller ones, and the air would be discharged into the rooms.

I believe in having the main trapped by all means if possible, but having it ventilated on a different plan, which others might not approve of, but one on which I would like to have practical opinion, and which I will try to explain.

I carry the soil-pipe full size through the roof. Trap all wastes as close to fixture as possible, using all-lead hand-made traps, which I consider best if properly made, excluding running-traps, which I don't think are reliable.

In the cellar, outside of all branches, place a half-S trap, branching the inlet in the back high enough so as to have a perpendicular fall of five or six inches to seal or outlet. Now, instead of carrying the upper part of trap outside through cellar-wall for fresh-air circulation, I return it back with 3-inch pipe through roof, and take a branch from all traps into it as close to the seal as possible, for vent to prevent siphonage and ventilate shorter branches. By not carrying this pipe as high as soil-pipe above roof, and being of different size and in the same atmosphere, they will be of different temperature, which, in my opinion, will insure a circulation at all times, materially aided by every discharge in the soil-pipe. I don't claim that I will have such a draught for my plan as by the former, but I do claim I will have a job that will stand the test of time much better.

This method I have adopted and found it to work well at all times and give entire satisfaction.

A. We have seen great numbers of fresh-air inlets, and have had them in use for years, but we never noticed the slightest odor from

the cause suggested by our correspondent. As a matter of fact, a properly flushed and ventilated soil-pipe does not contain a very foul-smelling air. To guard against even such a possibility we have, in our early numbers, advocated that the fresh-air inlet should terminate in a vault with a perforated cover. This contains a sufficient quantity of air to dilute any occasional whiff produced by a reverse current.

The plan proposed of carrying a 3-inch pipe back and up through the roof, and using this pipe also to supply air to the separate traps, would be quite impracticable in our city-built houses. Besides the expense there would be considerable friction to overcome —in some instances quite enough to disturb the seals of the smaller traps downstairs when a water-closet was discharged upstairs. We admit that this 3-inch pipe is better than none at all, but we can assure our correspondent that his apprehension about offense from properly arranged fresh-air inlets is groundless.

THE LOCATION OF FRESH-AIR INLETS IN CITIES.

THE following suggestions by L. M. Hooper, C. E., of New York, regarding the location of fresh-air inlets, are of interest:

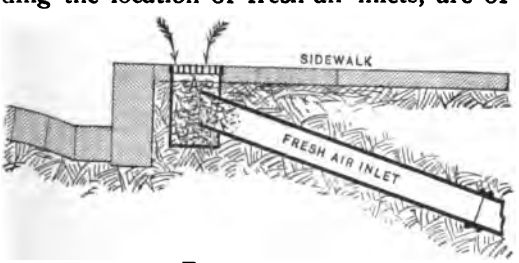


FIGURE 44.

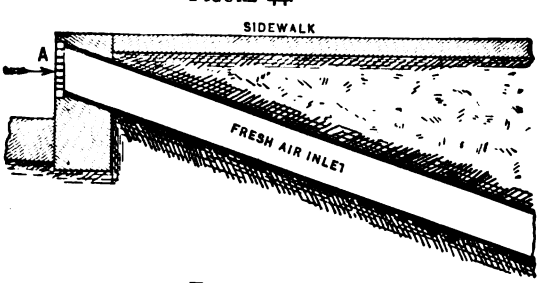


FIGURE 45.

"It seems to the writer that the location of the mouth or opening of the fresh-air inlet does not receive the attention due it. If the

fresh-air inlet is an aid to the more thorough ventilation and purification of the waste-pipes, which is now generally admitted, its mouth should be so placed as to be always free from the danger of becoming choked.

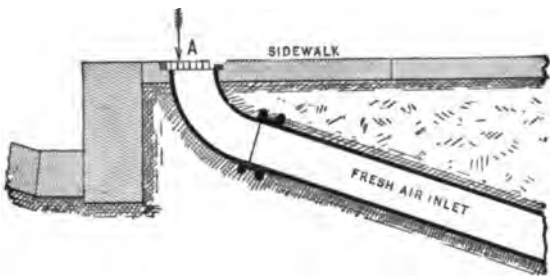


FIGURE 46.

"It is a fact, patent to all who have had occasion to use these inlets, that when they are run to a receiver or brick box in the side-

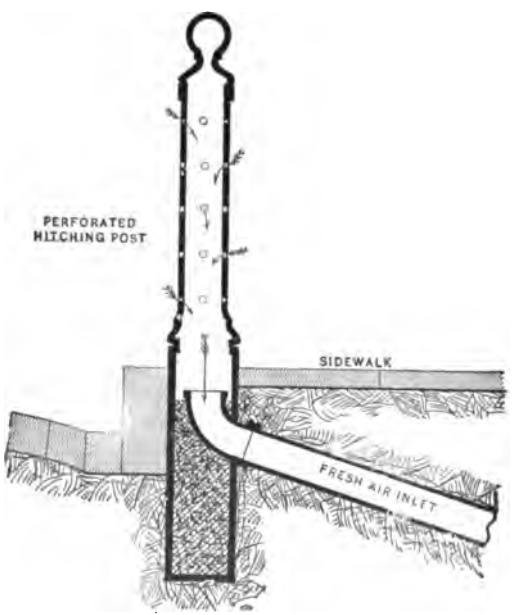


FIGURE 47.

walk, as shown in Figure 44, they soon become clogged and completely stopped up, and hence are worse than useless, as they give a false sense of security. When the fresh-air pipe is run to any point

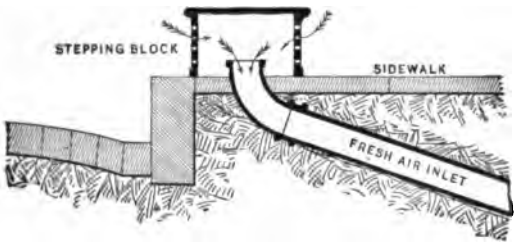


FIGURE 48.

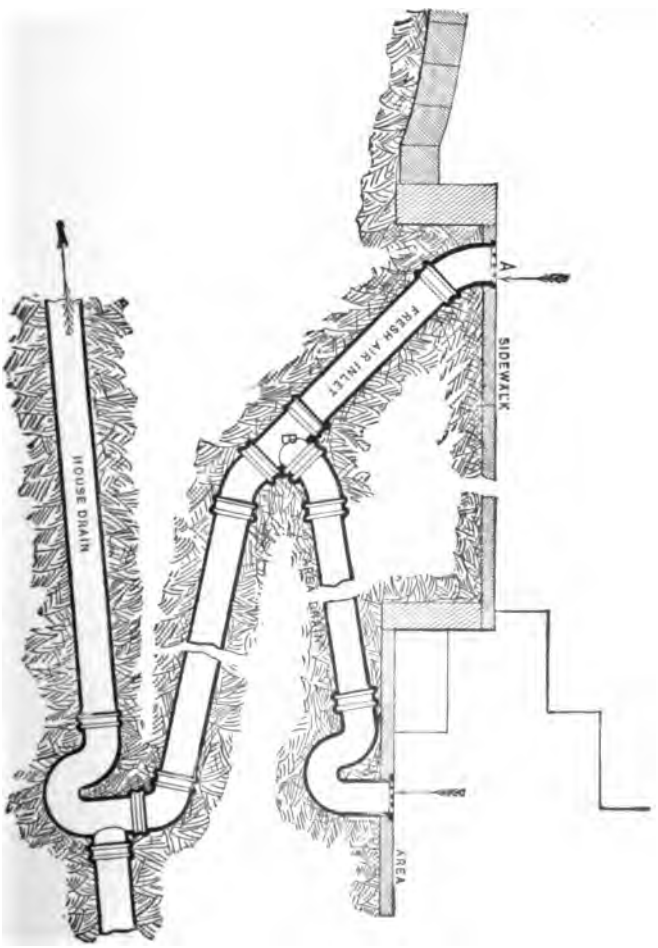


FIGURE 49.

inside the stoop line, it is usually terminated by a 'return-bend,' cowl or grating inside of a stoop or house, and there is little danger of its becoming choked, except from snow, ice, etc.

"In most cases, however, it is impossible to carry it to a safe distance from the house without taking it beyond the stoop line to some point on the sidewalk.

"When carried to the sidewalk the arrangement shown in Figure 44 is resorted to and the receiver (A) is sure to close up and thus become inoperative. These receivers are difficult to clean, and seldom or never are cleaned.

"There are three general methods by which fresh-air inlets may be made self-cleansing:

"*First*—By keeping dirt out. This may be done by terminating the pipe under a perforated tie-post or carriage-block, as shown in Figures 47 and 48, or by extending it flush with the curb, as shown in Figure 45.

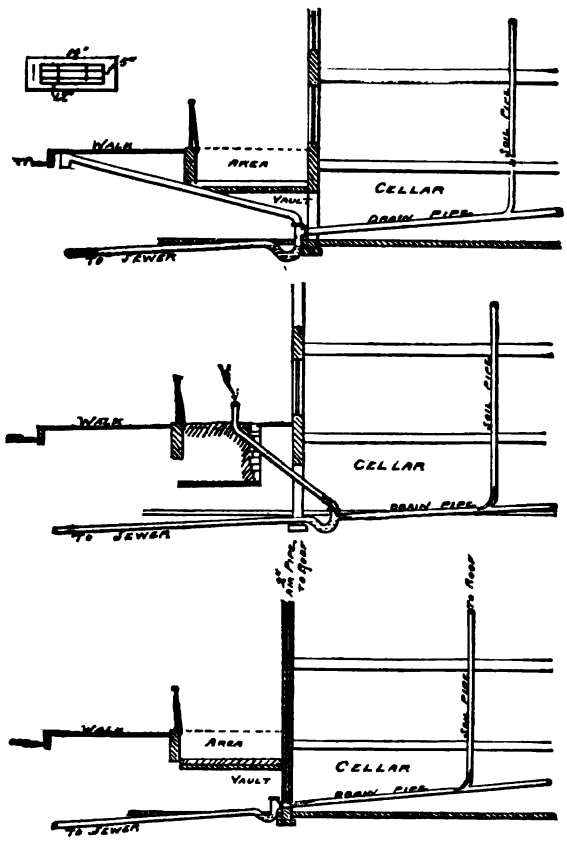
"*Second*—By giving to the pipe an inclination considerably greater than the angle of repose for dirt—say a little over 1 to 1—the dirt falling in will slide down into the house-drain. The mouth should be flush with the sidewalk, as in Figure 46. If arranged as in Figure 44, it will fill up no matter what the inclination is. When sufficient fall cannot be obtained from the curb to the house-trap to use the above method, the third method may be resorted to—*i. e.*, cleansing by water.

"*Third*—By cutting a small groove a few feet long on each side of the opening and parallel to the curb the wash of the sidewalk may be utilized to keep the pipe clean, or the water from the area may be carried into the fresh-air inlet, as shown in Figure 49. The fresh-air pipe from the opening to the point where the area-drain joins it should have sufficient fall to carry the dirt down to this point—*i. e.*, from A to B, Figure 49. From B, the fall need not be greater than one-quarter of an inch in one foot.

"If none of the above expedients is resorted to, it will be found convenient for cleaning to end the pipe as shown in Figures 46 and 49, as to clean it, it is only necessary to pour a pail of water into it. When arranged as in Figure 44 it is difficult to clean; even when the grating is removed and the accumulated dirt removed it is difficult to wash out the pipe itself."

METHODS OF ARRANGING FRESH-AIR INLETS.

SOME time ago, at our request, Mr. W. G. Elliot, C. E., made sketches of various methods of arranging fresh-air inlets to house-



FIGURES 50, 51, 52.

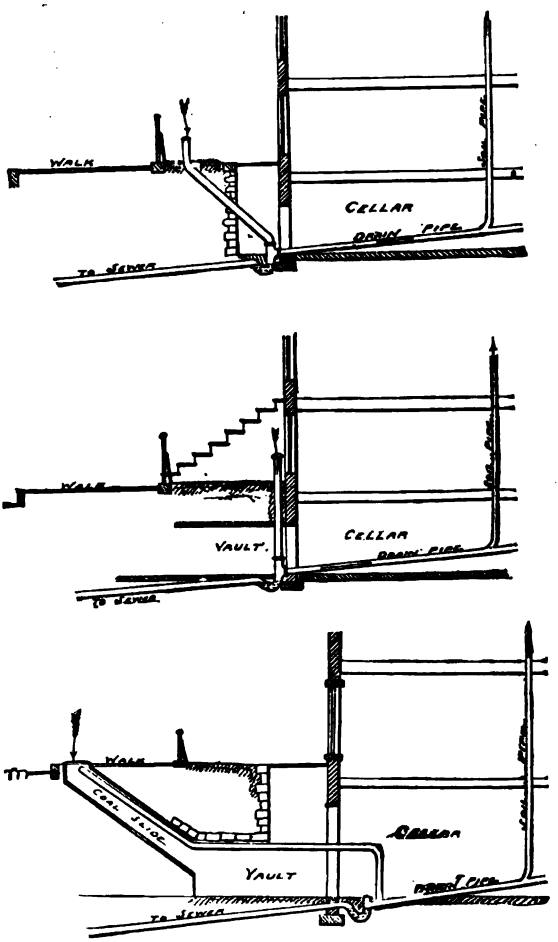
drains. We give here several of them, with his description.

Figure 50, showing the inlet at the curb with a 6 x 12-inch cast-iron grating to protect it, can be seen in operation in many places, among which may be mentioned several houses on the south-east corner of Sixty-Second Street and Madison Avenue. This method is extensively practiced by one of our largest plumbers, and seems to give universal satisfaction.

Arrangement Figure 51 is quite common. The inlet should be located as far from basement-windows as possible, and not extend

more than a few inches above the ground. The reverse action, however, takes place very rarely, if ever, and then only on a very hot summer day. A case of this kind can be seen at 125 West Forty-Third Street.

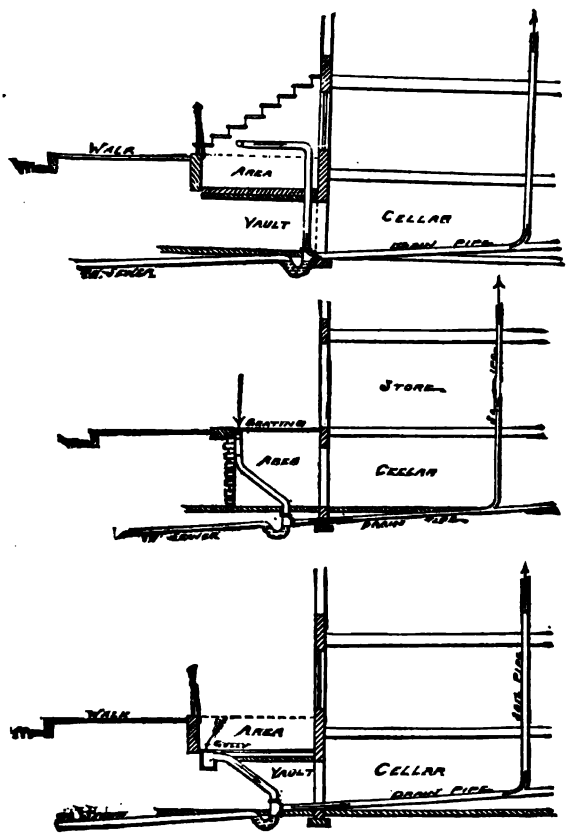
Figure 52 is found at 31 East Fifty-Seventh Street. There are many disadvantages in the construction. Being carried up through



FIGURES 53, 45, 55.

the front wall of the building, it cannot well be over two or three inches in diameter, while to be effective in any case it should be the full size of the soil-pipe. In addition to this, its top is so nearly on a level with the top of the soil-pipe that the difference in the tem-

perature of the air in the two must be very considerable to create a decided action. Beside these objections it has not even economy to recommend its adoption.



FIGURES 56, 57, 58.

Arrangement Figure 53 is very common and effective. Examples can be found at Nos. 51 and 53 West Forty-Second Street, and 26 East Twenty-Second Street. It is second only to that of Figure 50.

Figure 54 has been found but in few cases, one of which still exists at 105 West Forty-Third Street, where the inlet-pipe opened in the corner of the area against the adjoining stoop, and hardly more than eighteen inches from the basement windows.

It was probably so placed from motives of economy, as it would have cost several dollars more to properly extend it, and the plumber must do the best he can under such circumstances.

A recent innovation in the location of inlets has been found only at 11 and 13 Waverly Place (Figure 55). The pipe extends from the trap along the side of the coal-slide near its top to within a foot of the cover, where it turns into the side wall of the coal-slide, and terminates in the side of a small gully provided with an iron grating, as in Figure 41. In plan, this grating is beside the coal-slide cover, and within a few inches of it. The arrangement would seem to be objectionable from its liability to obstruction by coal-dust, etc., from the frequent dumping and shoveling of coal necessary in a large building, but this is simply conjecture.

Figure 56 is employed in a number of instances, among which can be cited 310 Madison Avenue and 11 East Forty-Fourth Street. Another was found at 18 West Fifty-Seventh Street. There seems to be no especial advantage or disadvantage in its application more than a mere alternative where no other arrangement is found as economical under peculiar circumstances.

Figure 57 was adopted in the case of an apartment-house, with stores beneath, at Eighty-Second Street and Tenth Avenue, where it was introduced after the completion of the building, and where a large amount of blasting would have been required to extend it to the curbstone.

On being tested some weeks ago, after having been in operation several months, it was found that the draught was inward and strong enough to draw in the flame of a candle held near it, and extinguish it. The current was not reversed even for an instant when two water-closets were simultaneously discharged into the soil-pipe. A similar arrangement can be seen at 49 Wall Street.

Several cases of the arrangement shown in Figure 58 have been seen, although no particular case can be cited. When the gully is located in the extreme corner of the area it would seem to offer all the advantages of Figure 53, the yard-washings and rain-water keeping it clean and free from obstruction.

With regard to the action of these air-inlets, there can be little doubt of their utility.

Popular opinion of them took its usual course, and the fact that they were new was for a long time sufficient to condemn them. Their rapid increase in number, however, proves conclusively that

they are not only becoming popular with the better and more experienced plumbers, but that they rarely, if ever, give offense either to the occupants in the houses or passers in the street. Many have been tested by the writer, but have never been found doing their work improperly, except in one or two cases where they had been connected on the wrong side of the trap, and were freely ventilating the sewers.

AIR-INLETS ON DRAINS.

Q. In the arrangement of the main drain in my house there is a good current of air in at the ventilating-pipe in the rear and out at the top of the soil-pipe; but one plumber tells me that we ought to have another just such current to ventilate that portion of the drain between the bottom of the soil-pipe and the trap in front, and wants to put in a ventilating-pipe just outside of the front wall of the house. Another plumber says that it is often found in practice that these ventilators work the wrong way, and bring a foul smell into the windows; he says he does not think any ventilator is needed in front, anyway—that it is of no consequence to have a current of air passing through the front half of the drain, and that he would rather not have it at all if he could not run it up to the very top of the house. He adds that the ventilator in the rear is dangerous, and ought to go to the top of the house. Now, will you please inform me, first, whether it is necessary to admit air into the front half of the main drain; and, second, if so, whether it would be safe to use the usual short ventilating-tube?

I desire also to say that my bath-tub wastes run into the traps of the water-closets, but I have never known of any smell in the tubs, and on trying the tissue-paper experiment I could not perceive any tendency to blow it off when a full pail of water was dashed into the closets. My water-closet traps are ventilated by a special pipe running above the roof; is this why the paper was not blown off? And does the presence of this ventilating-pipe remove your objection to the arrangement?

One more thing. We are often very seriously annoyed by the behavior of the hot water at the stops over wash-stands. It comes at times in violent spurts, with a disagreeable noise, a tremor of the pipe, and such a splashing of the water as to drench your cuffs if your hand is under the hot water, and even to spatter all over your body. Sometimes the water runs smoothly for a minute before the spattering begins. Can it be remedied, and how?

A. A fresh-air inlet should be taken in at the front just inside the main trap. In our opinion it is important to have no dead ends

in any part of the drainage-system—*i. e.*, air should be permitted to circulate through every part of it. If rain-water does not pass the house-drain there is no object in extending it behind where the waste from the kitchen enters it, and this pipe should extend through the roof unless the soil-pipe passes near these fixtures. Then if the traps are ventilated from their highest points there will be no "dead end" between the drain and these fixtures. The presence of a vent-pipe from your water-closet trap, doubtless to a certain extent, prevented the sudden compression of air when the water was thrown in your water-closet. This does not remove the objection to running bath-waste into water-closet traps, because this waste is liable to become foul, and it is a sanitary axiom to place traps as near the fixtures they are intended to serve as possible.

The spasmodic flow from your hot-water faucets complained of is doubtless due to the fact that air-traps have been formed in the hot-water pipes, caused by depressions or sags in these pipes.

SOIL, WASTE AND VENT PIPES AND TRAPS

A PLUMBER'S COMMENTS ON ARCHITECTS' WORK.

BY D. F. N.

In the construction of private dwellings a great many architects fail to provide for or give attention to the space between floors that must be occupied by the rough part of the plumbing work. They make a set of drawings showing the sizes of pipes for soil, vent and waste lines, as required by law, and specify the different kinds of fixtures to be installed, and then forget the space between the floor and the ceiling, under the bath and toilet rooms that must be left vacant for a proper length and width to receive the branch soil, waste and vent pipes which connect with the fixtures. In many instances it seems that no allowance whatever is made for the water supply pipes, which also branch out to these fixtures. They also forget the steamfitter's branches, the indirect heater man's requirements and those of the electrician and the gasfitter.

Now, what is the outcome of such oversight? The plumber starts some of his soil, vent and waste stacks and progresses with his roughing in work, when along comes the steam fitter with a kick, his claim being that the plumber has interfered with the run of his supply and return pipes, which cannot be run over or under the large soil branches, as his pipes must have the proper fall and must go just where he wants them to run and nowhere else. Of course the plumber keeps right on, as his pipe, being the largest in size, is, in his estimation, beyond question entitled to the right of way. This brings a consultation with the architect, who discerns where he is at fault in not showing in his drawing how to provide space in the framing for all these essential parts of the building. The natural resort to overcome the difficulty is to cut several inches into the wood beams, or, in the case of iron beams, to cut through the flanges, and, if there is not enough space then, it is a case of cutting through the web of the beam, detracting from its strength and the value of the building.

All this could have been avoided if the architect had given the proper consideration to the matter and had taken care of the differ-

ent parts of the building which he knew must be included. Even when the plumber was working in the cellar, and the steamfitter and other mechanics were about the buildings, it would have been a simple matter, and the course that would be pursued by a more considerate architect, to bring them into consultation in order to know their requirements and provide the space they needed, thus saving subsequent labor and providing the owner with a more substantial building. The plumber could tell the space necessary between the floors and the sizes of the chases to be left in the brickwork for his line of pipes, as shown in Figure 59. The flooring timbers should have a header to give the space necessary for the roughing in under the floors extending inward at least 2 feet from the rough wall. After the plumber's work is completed this could be filled in with short timbers or small I-beams for the flooring and to give strength. The angle irons on the ceiling below to which the

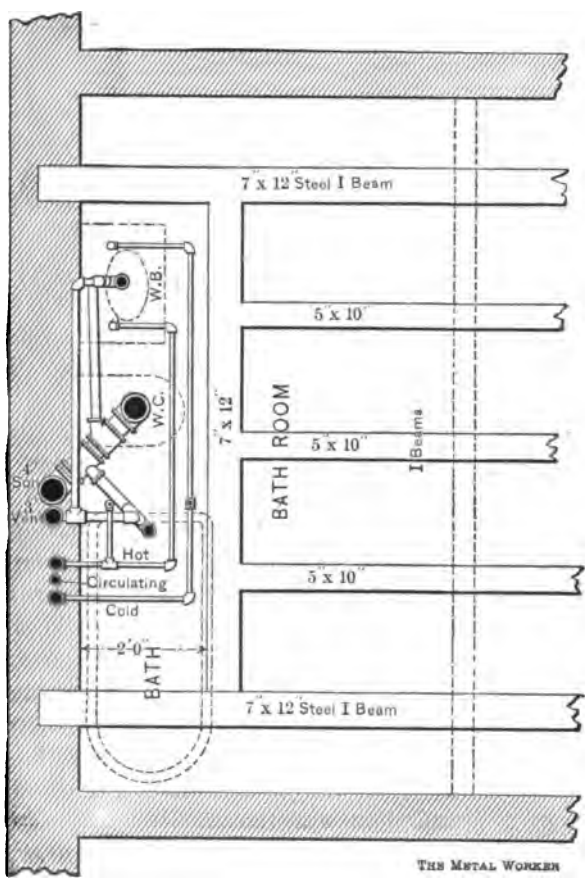


FIGURE 59.

Provision for Bathroom Pipes.

wire lathing is to be attached will take care of the finish underneath.

Such provision, carefully made, will give ample room and avoid trouble when the steam fitter, gas fitter and electrician come to work around the larger pipes of the plumber. The pipes and wires of the gas fitter and electrician, however, ought to be confined to the halls and kept as much as possible from under the floors to avoid trouble in case of a leak or a ground. Then, the tiled floors and walls of bathrooms would not have to be marred in making their repairs. Only a few days ago a plumber was given an order at the shop to start a job in what we in these days call a mansion. He went over the building and found chases left in the wall for the waste, soil, vent and supply lines. There were nine of these chases, each having an 8 x 3 channel running hard on the wall across their face, and there was not one of these chases that was not 5 inches scant in width and 2 inches short in depth. In order to get the pipes inside of the plaster on the finished wall line, as the specifications imperatively called for, every one of these chases had to be cut out the required width and depth to admit the pipes. This consumed sufficient time to make a material delay in the whole work.

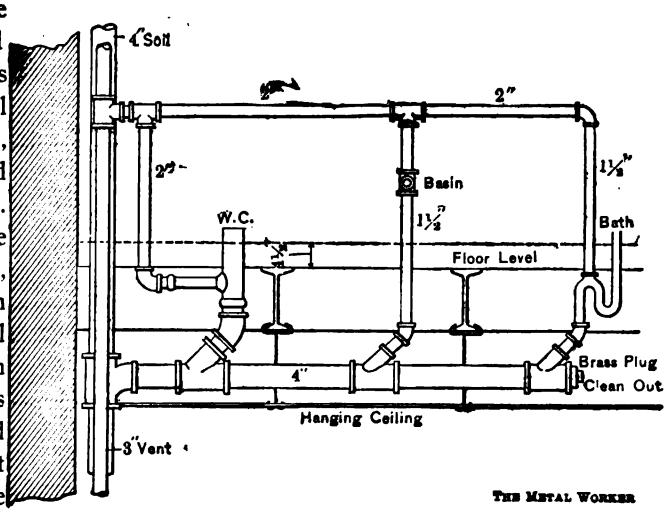


FIGURE 60.

Drainage System Covered by Hanging Ceiling.

In some cases it is advantageous to carry the horizontal rough plumbing work under the original ceiling, and then, when it is completed, cover it with a hanging ceiling, placed underneath the several pipes so inclosed. Such an arrangement is shown in Figure 60. In office buildings, schools, lofts and other buildings, where the

horizontal drainage branches must always be accessible, they are hung below the ceiling and left uncovered, similarly to the arrangement shown in Figure 60, without the hanging ceiling. This renders them readily accessible for extension or repairs, and, when the work is carefully arranged, neatly done and properly painted, the appearance is not objected to in buildings of the character mentioned.

In some buildings the plumbing is carried across the tops of the beams or arches and a platform with a 7-inch step at the entrance of the toilet room covers the pipes. The horizontal drainage run is brought out to the face of the marble base, where the platform terminates, and a cleanout is arranged for use in case of necessity, as shown in Figure 61. This makes it far easier for the plumber to do his work, and saves him the labor of building scaffolding and putting in hangers to support the pipes, as is required in work arranged as shown in Figure 60. Then beam clamps with hangers attached to them must clasp the bottom of the I-beams at one end and encircle the pipe at the other.

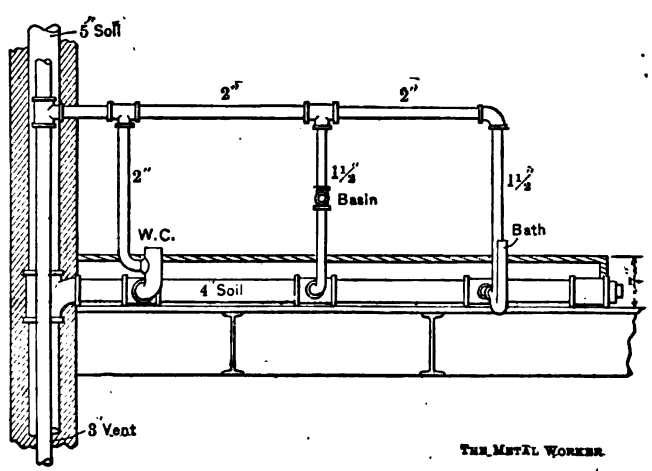


FIGURE 61.
Drainage System Covered by Platform.

An easy method of connecting a 4-inch lead bend for a water-closet, where there is scant space between the ceiling and the finished floor, is shown in Figure 62. This will be found convenient in an overhauling job where new wrought-iron pipe is substituted for old cast-iron or lead soil pipe. Under such conditions, when the Ys or T Ys are placed between the ceiling and the finished floor, it is found that the space is too small to allow a lead bend to turn, be it a short or a long bend. In such cases one method makes it necessary for the round joint to be wiped in a mean place between

the beams, with not enough space between the bottom side and the ceiling to get up the heat necessary to wipe it, even with the assistance of a torch on the fitting, besides having the trouble of the brass nipple oxidizing from continually pouring on the metal, or the metal sweating through to the inside of the bottom. This can be gotten over nicely if the brass nipple is wiped on the bend on the bench, and then folded almost flat at the crotch, as shown in the lower part of Figure 62, which makes the bend very similar to a straight piece of pipe. It can then be screwed into the fitting in the vertical soil line in the limited space provided for the work. When nearly screwed up tight it can be left lying on its side and an opening can be tapped in the side for the 2-inch lead vent pipe. When this branch is wiped on to the lead bend the bend can be turned a half turn home and tight. Then it is a simple matter to work out the kink at the throat of the bend with a dummy made of a ball of lead on a copper or brass wire. A careful workman can bring it to its proper shape, and almost as smooth as when it left the factory. Only one other joint will be required, and that is the one shown at A in the upper part of Figure 62, connecting the lead pipe with the brass fitting that is to make up with the galvanized-iron vent pipe.

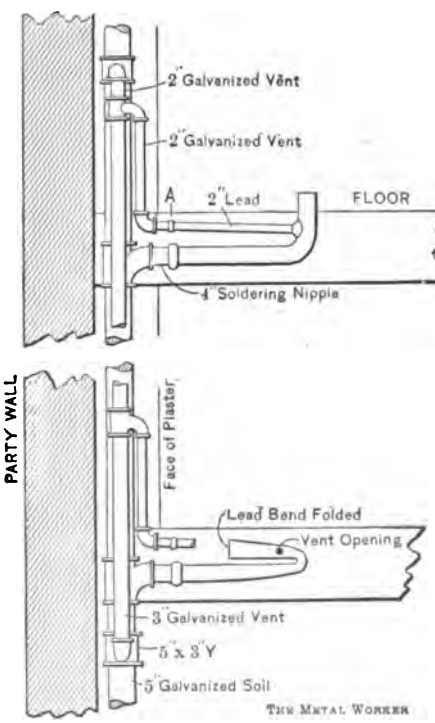


FIGURE 62.

A Wrinkle for Overcoming Difficulty and Saving Labor.

If the architect would only confer with the plumber all of these practical details, which the plumber does not expect him to know, would be explained to him, and he would make provisions that would secure a correctly planned piece of work, which would be better for his client, easier for the plumber and cheaper for both the plumber and the owner. When a plumber secures a contract he should, as soon as he has studied his plans, have a talk with the architect and explain some of the details that must be observed and point out some of the contingencies that may arise with the other mechanics. This may not always be an agreeable task, nor such information be courteously received, but inasmuch as it will result in a better completed job, and a saving of money to several other mechanics, the plumber is justified and should feel it his duty to take up the battle, even if it may require the expenditure of some energy. The architect, although he may at times seem curt, has many things on his mind, but, in the main, is thankful for assistance on matters with all the details of which he is not familiar. It is a simple matter to bring him to his senses if he is unreasonable, by carrying out some of his outrageously incorrect plans and then pointing out to him that he is the Shylock that so nominated it in the bond.

VENTILATING SOIL-PIPES.

Q. Is IT more desirable to ventilate soil-pipes upon the roof or into a heated chimney-flue?

A. Soil-pipes should always be extended to the open air, either through the roof or at a proper point on the side of the building, in as direct a line as can be found above the upper fixtures by which drainage is admitted. The objections to having them enter a chimney-flue are as follows: The flue may not *always* be heated. Even kitchen-flues are sometimes cold in summer, when temporary stoves are used in some outer room for cooking. At such times the draught is very apt to be downward, bringing the air from the soil-pipe directly back into the house. Moreover, the joint where a metal pipe enters a brick flue is never a tight one for any length of time. The iron pipe is changing its length with every change of its temperature, working back and forth, and crumbling the mortar away around it. Such joints have given out a very unsavory smell in certain houses where the writer has seen the experiment tried.

If the soil-pipe is extended up inside the flue quite to its top and three feet above it, there may not be as much objection. But such a position renders it difficult, if not impossible, to repair it without taking down the chimney, while the gases given off by burning coal are quite corrosive to cast-iron, so the pipe will not endure so long in a chimney as if outside of it.

While upon this subject, it may be well to refer to the need of securing a permanently open end for the soil-pipe in the open air. The severe weather in winter gives rise to considerable accumulations of ice at the openings of such pipes. It arises from the condensation of the watery vapor that always comes up from the drains below, and which freezes to the side of the pipe as fast as it condenses. An inspection of a number of roofs in Boston has shown a collection of ice in all the pipes so examined, from half an inch to an inch in thickness. Where cowls or caps of any kind are used, the openings are sometimes entirely closed. Straight open ends of four inches' diameter are the safest.

SIZE OF VENTILATING-PIPES FOR TRAPS.

Q. WILL you be kind enough to inform me through the columns of your paper on two points which I have no means of deciding—viz.:

First—What proportion should the area of a pipe, ventilating a trap, bear to the area of the pipe on which the trap is located?

Second—Is the placing of a gully with trap, at level of yard, the best way of breaking connection between a rain-water leader and the main house-drain? Would frost injure its efficiency?

Being somewhat of a novice in sanitary engineering, an answer with the weight of authority your paper carries with it will greatly oblige.

A. The size of a pipe used to ventilate a trap should be as near the size of the trap as practicable and depends largely on the distance such a pipe has to go to reach air. Moreover, if the climate is a frosty one, say above a latitude of 40 degrees in the United States, the part of the pipe extending through the roof should be not less than four inches in diameter in any case, to prevent its being filled up with ice from condensation.

Second—The gully with strainer on a level with surface of yard with a trap below is a good method of breaking the connection of

rain-water leaders with drains, provided the trap is supplied with water by some more reliable source than the rain; otherwise it might dry up and leave the trap inoperative; also, provided the water in the trap is protected from freezing, which is purely a local question, depending on climate and exposure.

HOW TO PREVENT CONDENSATION FILLING VENT-PIPES.

Q. WILL you please advise me what means plumbers in your city take to prevent condensation filling vent-pipes and making them no good? It is not always possible to give them a steady pitch.

A. They are so arranged that there are no pockets or traps in them, and so that the water of condensation can flow back to the waste-pipe in some way. It sometimes requires considerable ingenuity to accomplish this, but that should be exercised every day in the plumbing business.

WHY TRAPS SHOULD BE VENTED.

"THE writer of this letter recently submitted a bid on the plumbing-work of an eight-story and basement building, having water-fixtures on all stories. There are fifteen stacks of cast-iron pipes extending through from cellar to roof (eight of 4-inch and seven of 2-inch pipes). The fixtures consist of 159 wash-stands, fifty-five water-closets (cistern), about the same number of bath-tubs, together with other fixtures. One of the features of the specifications is that the traps of the water-closets alone are all the traps which are required to be back-vented in the building. Many of the other fixtures, particularly the wash-stands, are remote from the upright pipes into which they discharge. One 2-inch pipe receives the waste of fourteen, and two other 2-inch pipes receive the waste each of twelve wash-stands. The specifications state that no back-vent pipes are to be put on these wash-stand traps, and no other means are devised to preserve an equilibrium of pressure between the inside of said pipes and the atmosphere. The writer suggested that the lead-safe pans, four pounds per square foot, be changed to three or two and one-half pounds per square foot, making a saving of nearly two tons of lead, the value of which could be applied toward back-venting fixtures. The suggestion was not favorably received by the architect. The proprietor of the building is desirous of having the best class of

work. The writer will be pleased to read any criticisms on the above, or any recommendations you may think called for."

The above letter has a somewhat melancholy and discouraging effect upon all who have been laboring to convince the public that it is useless to expect traps to serve any good purpose when placed on such small waste-pipes as two inches, unless every trap is vented to the open air by a pipe as large as the waste itself. The experiments of Messrs. Philbrick and Bowditch proved this most conclusively. We can only regret that such an architect as is above referred to should have neglected to read that report to the National Board of Health. No one who had read the clear statements contained therein could fail to appreciate the risks incurred by placing traps under fixtures on 2-inch waste-pipes with no air-vents. Such traps are mere "man-traps" and not water-traps, for they give a sense of security to the owner or occupant of the building when in reality none exists. If the plumbing should be executed in the manner above described by our correspondent, it will not be many weeks after occupancy before the traps can be found empty for about half the time under the wash-basins and the whole length of their waste-pipes ventilating into the rooms which they are intended to serve. No better contrivance can be devised for supplying foul gas in a constant stream to the interior, after artificial heat is applied in winter, than the methods above proposed. The large number of basins draining into single lines of pipe will add to the risk by the frequent draughts of air which will rush down, gurgling through the traps of these wastes to supply the vacuum created by the discharge of other bowls connected with the same line. The remoteness of some basins from the vertical lines constitutes another element of danger, as every plumber will appreciate who has had occasion to open and clean out the horizontal waste-pipes used in such cases. The 2-inch wastes used in such lines, under the flows, will soon become nearly filled with a putrid, slimy lining, which by its constant fermentation will supply gas enough to contaminate a whole block. We hope the proprietor of this building will be invited to read the record of the experiments alluded to on this subject, even if the architect he employs does not find time to do so. In these days of cheap printing the great trouble is to know how much to read and what selection out of the plethora of current literature. But however difficult it may be for all proprietors of buildings to keep well posted on such subjects, there is less excuse for the architects, who should at least be able to

attend to the specialties connected with their professions and make proper use of the facts placed before them from reliable sources.

HEIGHT FOR VENTS.

Q. WILL you explain how and at what height from the floor to rough in vents for lavatories with legs and traps, and side vents for closets?

A. The proper height for branch vents for lavatories taken from a main vertical stack is 3 feet, giving a height above the fixture of 6 inches. In cases where the lavatory is in front of a window that is low, a height of 2 feet 8 inches will be sufficient. The vents should be arranged as shown in Figure 63, which gives the various heights and dimensions. In New York City a 1½-inch vent pipe can be used

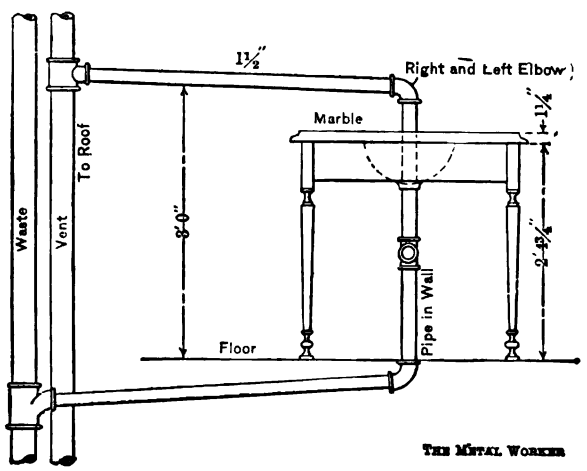


FIGURE 63.
Lavatory Dimensions

where the run is less than 6 feet, but for runs over 6 feet the vent must be 2 inches.

For water-closets, as shown in Figure 64, the height for the branch vents taken from the main vertical stack is 2 feet 4 inches,

or about 6 inches above the top of the fixture. The branch vents, however, connected with the vent line at the height mentioned must be carried down below the floor not more than 5 inches to the center, and connected with the vertical part of the lead bends directly under the closet. They should have a slight pitch to the bend. While on this subject some other dimensions in reference to other types of lavatories may be of interest to the trade. Where plain basins are used, with a straight trap nickel plated, the height of the waste outlet should be 16 inches above the finished floor to the center of the out-

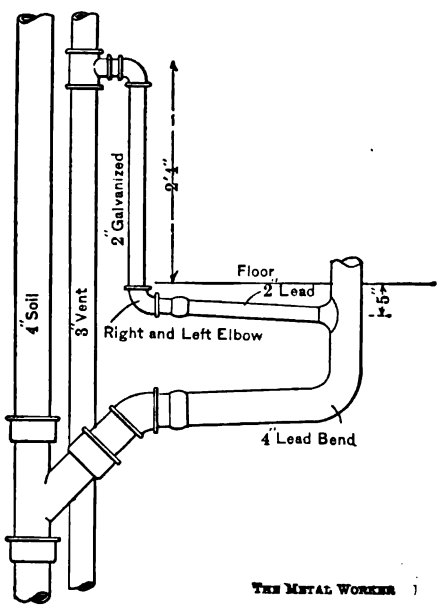


FIGURE 64.

Water-Closet Dimensions

let; lavatories with Yale waste and bowl, 12 inches from the center of the outlet to the top of the finished floor; with oval bowl and Unique waste, 13 inches from the center of the outlet to the top of the finished floor, and with the Hygeia bowl standing overflow waste, 14½ inches from the center of the outlet to the top of the finished floor.

HEIGHT FOR BATH-TUB AND SINK VENTS AND TRAPS.

Q. WILL you give me some information in reference to bath-tubs and kitchen sinks? I desire to know the height to rough in vents for bath-tubs, also vents for sinks having legs and with traps.

A. All vents for sinks, bath-tubs, or other fixtures should be taken as near as possible from the crown of the trap, and should be carried up above the highest point of the fixture with which they are connected and then carried over to the main vent stack and connected with it. In a case where a door or closet may interfere it is necessary to carry the vent line up higher and then across over to the vent stack. The reason for carrying the vent pipes up above the fixtures is to prevent the fixture discharging through the vent pipe in case the waste pipe becomes choked up, when the stoppage might not be discovered and the vent pipe might continue to perform the functions of the waste pipe until some disagreeable outcome would cause its unnatural use to become known. In Figure 65 a bath-tub and a sink are shown connected with the same waste and vent lines. It will be seen here that the tub discharges through a 2-inch trap, which continues onward to the main line, and a 1½-inch vent pipe is connected near the crown of the trap, and carried up to a height of 2 feet 3 inches, or above the top of the tub, which is 2 feet in height. The lower portion of Figure 65 shows a sink 6 inches deep set with its top 2 feet 6 inches above the floor. The sink discharges through a 2-inch

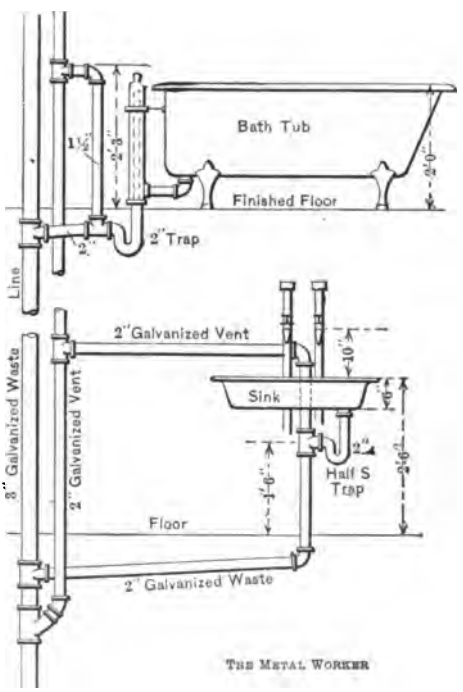


FIGURE 65.

Dimensions and Arrangement.

half S trap connecting into the opening left 1 foot 6 inches above the floor. The bibbs are provided with air chambers and are set 10 inches above the top of the sink. The height of vents and wastes for bath-tubs depends entirely upon the height of the tub and the kind of fixtures used in connection with it. The outlets for sinks having lead or brass traps of the half S type should be as follows:

	Inches.
For sinks 5 inches deep	19
For sinks 6 inches deep	18
For sinks 8 inches deep	16
For sinks 10 inches deep	14
For sinks 12 inches deep	12

A sink discharging through a grease trap or interceptor is shown in Figure 66. The outlet from the interceptor should always be placed lower than the sink. It will be noticed that the height to the center of the discharge from the grease trap is 19 inches, while it is 24 inches to the bottom of the sink. This grease trap consists of a central chamber through which the discharge from the sink passes, surrounded by an outer cylinder with a space between, through which all the cold water used at the sink passes to cool and harden the grease that may be carried off with the waste water. A cleanout should be provided in the elbow below a sink, so that in case of the grease hardening in the pipe it can be removed with a wire.

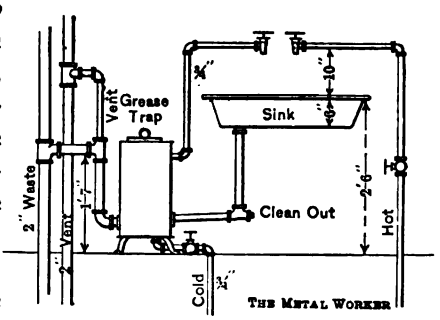


FIGURE 66.

Grease Trap Connected.

DESTROYING THE EFFICIENCY OF A VENT PIPE.

BY J. D.

THE plumbing which is done so as to reflect the most credit so far as workmanship is concerned is often so arranged as to entirely frustrate its object, and in some instances the work becomes positively

dangerous. Figure 67 shows some plumbing work recently found in a building. Owing to the location of the lavatory it was difficult to carry the vent from the trap up and over to the soil stack. In consequence it was taken from the top of the trap and carried down to the floor and run across under the floor to the soil stack, where it rose to a point above the highest fixture and was connected with the soil stack. If this pipe could have been kept clear it might have performed some of the functions of a vent pipe, although the number of turns in it would have added greatly to the friction of air passing and might have prevented an influx of air with sufficient rapidity to prevent the trap of the lavatory being siphoned when the water-closet connected with the same stack was flushed. The workmanship throughout was, however, above criticism.

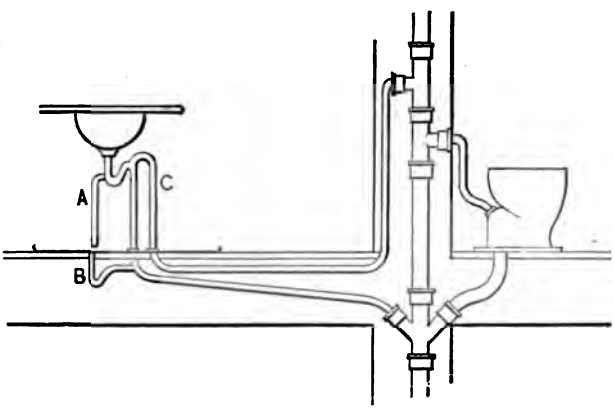


FIGURE 67.

Destroying the Efficiency of a Vent Pipe.

The plumber had also provided a safe waste under the lavatory so that in case it should overflow from any cause instead of flooding the building the water would be caught in the safe waste and pass off. The outlet from the safe waste, however, was a comparatively small pipe arranged with a trap in it and connected with the waste pipe from the lavatory. The plumber had realized that it was possible that the water in the trap at B would be very likely to evaporate and would need replenishing. To provide water in the trap a pipe was connected with the waste in the lavatory as shown at A, so that when the lavatory was discharged some of the water would pass down A into the safe waste and from it to the trap B. He did not realize that by discharging water from the lavatory the trap B would invariably be siphoned and that no water would remain in it. The odor in the room was unbearable and it was found on examination to

be as shown in the drawing. It was necessary to disconnect the pipe A entirely and carry a pipe from the safe waste to the kitchen, where arrangements were made for it to discharge, in case of an accident or overflow, into the kitchen sink. To prevent odors from the kitchen passing up this pipe the end was turned horizontally at the bottom and a flap valve placed on it which would in no way interfere with the discharge, yet would close the end of the pipe and prevent air currents and odors passing through it. The pipe C contained filthy water up to a point 3 inches above the top of the horizontal part, so that it was utterly impossible for air to pass through it to prevent siphonage. The pipe had to be disconnected entirely and owing to the construction of the building this vent pipe carried up through the building and above the roof independent of any other stack of pipe, and the opening in the soil stack closed, to which it had been formerly connected.

The system has now been in operation for some time and the disagreeable odors have disappeared, and when the water-closet is discharged it is found that the seal of the trap of the lavatory is no longer affected by the discharge. It points out the advisability, if not necessity, of filing with proper officials a plan of all work that is to be done and an inspection of the work after it is completed.

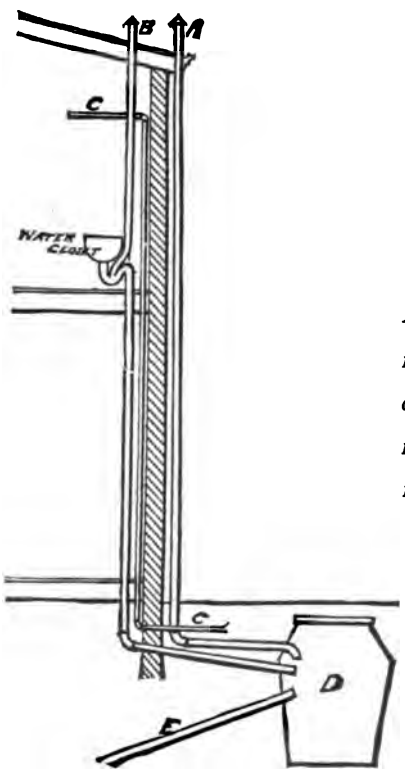
DEFECTIVE VENT CONNECTION.

Q. ENCLOSED please find diagram of our office, with drainage arrangements, which are defective to the extent that at times we are almost driven from the building on account of foul gases. Any suggestion you can make will be thankfully received and acted upon. I may say we have a bountiful supply of water for the water-closet.

A. From the sketch sent it looks as though your water-closet trap siphoned itself out whenever used, the vent to protect it being placed inside the seal instead of outside. If this is so, the gases from your cess-pool would naturally be drawn into the warm interior

of your house, rather than up the vent-pipe on the outside, especially in winter.

OBJECTIONS TO RUNNING VENTILATING-PIPE INTO CHIMNEY-FLUE.



A—Vent from cesspool.

B—Vent from water-closet trap.

C—Steam-pipe.

D—Cesspool.

E—Overflow.

FIGURE 68.

Q. AGAIN I will trouble you in regard to a question. I am about to fit a water-closet up in a bath-room, and I want to run the 4-inch pipe to the roof and put a cap on it, but the owner wants it run into the chimney, which is along side of the closet. I tell him it will not be as good a job as if taken through the roof, but he differs from me. Now, from what I have read, the chimney-flues are condemned in general. Please tell me who is right.

P. S.—The container will be ventilated.

A. We repeat an opinion often given. The soil-pipe should be taken through the roof, not run into the chimney-flue. You cannot depend on having an up-draught in the flue all the time. It is difficult to make a joint where you run a soil-pipe into the chimney which will keep tight, and the soot is liable to choke up the end of your ventilating-pipe.

OBJECTIONS TO GALVANIZED SHEET-IRON SOIL-PIPE.

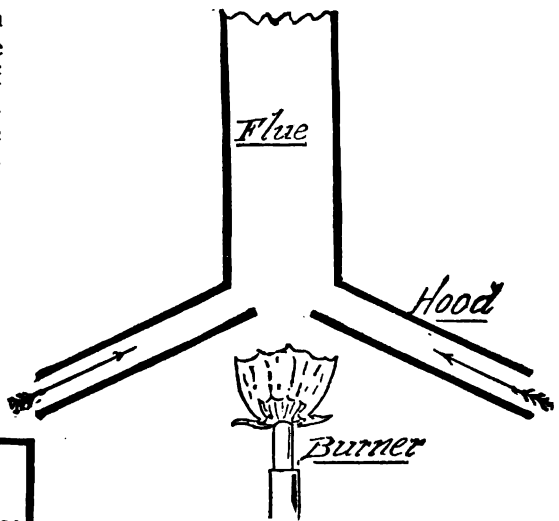
Q. In a specification with plan, for a cheap farm-house and barn, I notice that the architect provides for a 4-inch tile-drain from cesspool to sink, the sink to be connected with the drain by a 2-inch lead pipe; also that a cast-iron slop-hopper is to be connected with the drain by a 3-inch No. 24 galvanized-iron pipe. Now, is not this bad practice? Will there not be considerable difficulty in connecting a 2-inch lead-pipe with a 4-inch tile-drain, so that there will be no leaks? and should not the use of galvanized-iron for waste-pipe be condemned, on account of difficulty of making a tight seam?

A. You are quite right in your apprehension about the use of galvanized sheet-iron between hopper and drain. It is a little better, possibly, than canvas, because it might be tight a little longer, but we should expect it to be full of holes inside of a year. With care the lead pipe might be connected with the tile-drain, but a 4 x 2 Y should be used, and the connection should be below ground and carefully cemented, for, while it might be water-tight, we think it doubtful whether, if exposed, it would long remain gas-tight.

WHERE TO PLACE BURNERS TO VENTILATE FLUES BY GAS-JETS.

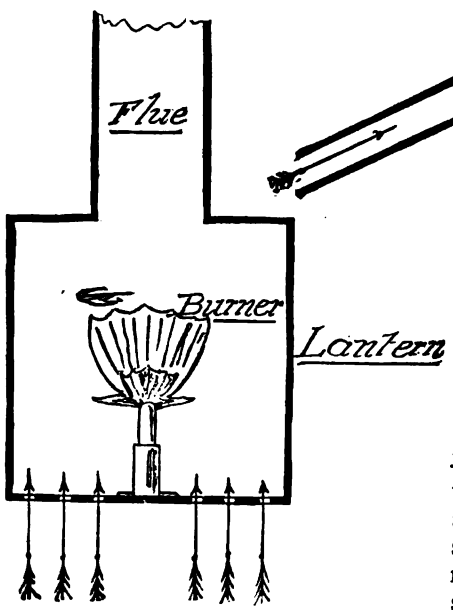
Q. I wish to produce a draught in a ventilating flue by using a gas-jet for that purpose. Two arrangements of the jet have been suggested. One is about as follows:

The gas-jet is set under a flat metallic hood, made double, as shown in the sketch, it being intended that the jet shall heat the metal of the lowest hood, which will in its turn heat the air which passes in between the two hoods, or parts of the hood, as indicated by the arrows. The other is to simply in-



FIRST PLAN

FIGURE 69.



SECOND PLAN

FIGURE 70.

close the jet in a small chamber or lantern in the flue, as is the very common practice. I am told I will produce a stronger current by the first method, because I heat a large surface, which in its turn heats a large stratum of air, while with the lantern I only heat a small surface of air as it comes in contact with the flame. Nevertheless, I prefer the second, because I think I can heat air better by *bringing it dircctly into contact with the flame* than if I used the flame to heat a metal surface first. Indeed, the idea first suggested seems to me like inventing fictitious heat to make up for the loss which always occurs in heating the metal surfaces.

A. We believe the best results will be secured by the latter plan, since less of the heat is lost by radiation into the room.

A SOIL PIPE ROOF CONNECTION.

BY S. D. R.

WITH the plumbing regulations of many cities requiring that the vent stack from a plumbing system shall extend through the roof, the problem of making the roof water tight at the place of exit is presented. Where the roof is flat or of sheet metal it is a comparatively easy matter. Figure 71 shows the method of making the roof connection tight when it is through a shingle roof having a sharp slant. The soil pipe stack should be cut off so that the hub extends to a short distance—1 or 1½ inches—above the roof at the top edge. A piece of sheet lead is best adapted for making a tight connection. A hole should be cut in the lead about 1 inch smaller than the diameter of the soil pipe that it is to be used in connection with. It should then be notched with a pair of shears so that it may be turned down inside of the hub, and should be dressed down around the hub so that it will lie flat on the roof; and when used on a shingle roof it should extend far enough under the shingles so that the manner of breaking the joints in the shingles will prevent water from passing under it. The piece of lead should be sufficiently large to extend on each side some distance away from the pipe, and also at the bottom. From the nature of lead, it can be very readily dressed or beaten up to whatever shape is necessary for it to lie flat on the roof and to extend up to the cast iron hub. After this part of the work has been done a continuation of

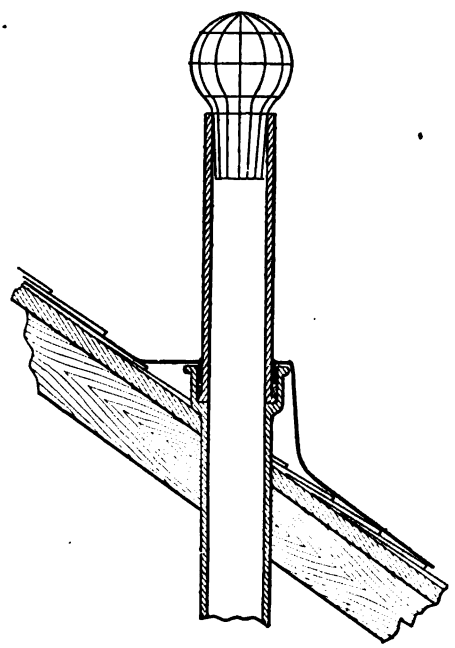


FIGURE 71.

A Soil Pipe Roof Connection.

the soil pipe stack can be made by inserting a piece of pipe into the hub end, as shown. The joint should be calked with oakum the same as in the regular soil pipe, and then melted lead poured in the hub until it is flush with the top. By this means a perfectly water-tight joint can be made. The illustration shows a wire ball used on the top of the vent stack to prevent the entrance of birds, leaves and other matter. This style of vent protection as used by some is open to objection. It is quite possible for it to be effectually stopped in a snow storm. A better method is to use some sort of a top or cap which prevents water from entering the vent stack, and which presents a sufficient space for the entrance and exit of air, but not enough for the entrance of birds. With a cap that extends sufficiently over the pipe there is little danger of the vent becoming entirely clogged with snow or sleet.

DANGER OF SOIL-PIPE TERMINALS FREEZING UNLESS ENDS ARE WITHOUT HOODS OR COWLS.

Q. DURING a cold snap I was called up-town to investigate the cause of escape of sewer-gas into the house of a well-known gentleman of this city. I knew the house-drains were thoroughly ventilated, and was at a loss to locate the cause. Upon examining the work we found it apparently all right, but in spite of that fact, when we lifted the plunger of the water-closet, the traps immediately siphoned out, and on going to the roof, thinking something was wrong there, imagine our astonishment at finding the ventilating-cap frozen solid. Other houses in the same row were found to be in the same condition; the damp vapor rising through the sewer had struck the upper or dome-like portion of the cap and gradually frozen its way down like an icicle, and finally closed it tight. In our climate this is liable to happen at any time during the winter, and, in my opinion, calls for an air-cap of a different pattern. Upon examining the present air-cap you will wonder how the sewer-gas escapes from it, as the dome falls down over the lower or straight part at least one-fourth of an inch, while it really ought to stand clear above it at least 1½ or 2 inches. This would also prevent its freezing, as the space would not be so confined, and would be more difficult to fill up with ice, as there would be no support.

Either remodel the hood or dispense with it entirely, and leave the end of the pipe open to the air. This, I know, would be open to

objections, as malicious persons would probably drop obstructions down the pipe.

A. We think this letter of great importance. We have hitherto preferred the open pipe or a properly constructed hood to a return-bend or cowl, as we consider the latter liable to be closed by ice during very cold weather. From our correspondent's experience it appears that the hoods were so constructed that ice readily formed and closed them, while return-bends were found open. After this experience we should advise that open pipes be used, and, if it is necessary to prevent articles from being thrown down the pipe, our preference would be an open-mouthed pipe sufficiently high to be beyond the reach of children, and properly supported.

A similar experience to that of our correspondent was brought to our attention also about that time, and on frequent occasions since we have expressed our objection to the return-bends or hoods of this description for this climate, and even the wire-basket, in localities north of this, we should apprehend, would close up and become a ball of ice, unless the mesh were large.

PROTECTING TRAPS FROM FREEZING.

Q. WILL you give me information on the following questions? Is salt water the next best thing to glycerine to fill traps with in a vacant house in winter to prevent freezing? At what degree does standing salt water freeze? How much salt is necessary when a gallon of water is required? Does coal oil evaporate too fast to use for filling the trap in an unused building? What have you used in your practice in filling traps to prevent freezing?

A. Salt water in the form of saturated brine freezes at about 5 degrees F., and then in a porous or not solid state. Chloride of magnesium, saturated, requires a still lower temperature to freeze. It is employed in the ice factories as the circulating medium for making ice. It does not attack iron as much as common salt. A solution of glycerine and water in equal parts will afford ample protection to pipes and traps and does not freeze solid at zero, Fahrenheit. It has much less rusting quality than a brine of common salt. The glycerine can be poured directly into a trap with water in it. It soon diffuses itself.

HOW TO DETECT ACCIDENTAL DISCHARGE INTO TRAP VENT-PIPE.

Q. I HAVE had a case of plumbing brought to my notice, where the pipe from a sink stopped up between the trap and the soil-pipe. How long it had been so no one seemed to know, as the water that should have passed down the waste-pipe passed over through the vent-pipe, and found its way into the soil-pipe through the vent-drip. What is the usual way in your city to prevent this?

A. When the vent and soil pipes are carried in a recess back or near the sink, introduce your Y-branch into the vertical line of vent-pipe, half-way between the bottom and the upper edge of the sink, or other fixture. This will cause the water to show in the sink should the waste-pipe be stopped beyond the trap, but will not allow the sink to run over.

If the pipes are all below the floor, arch the vent-pipe up behind the sink sufficiently high to raise water into the bottom of the sink, but not high enough to run over.

RISK ATTENDING THE OMISSION OF TRAPS AND RELYING ON DRAIN-VENTILATION BY FLUES.

Q. I WOULD like to have a few questions answered on the following plan. It is proposed to build a new wing to the county jail here, and according to the plans there are no traps on any of the hoppers, nor is there any vent-pipe from the top of soil-pipe, where the upper hoppers connect. There is to be one vent-pipe at back of building, where the rain-water pipe acts as another. Then in the front there is a 20-inch cast-iron smoke-stack, and on the inside of that is an 8-inch cast-iron pipe for vent-pipe. Now, I would like to know if the 3-inch outlet from the hoppers is not too small; also, if they should not be properly trapped? Or does the vent-pipe that goes up inside the smoke-stack take all the foul air down and up it, without letting any smell back in the cells? I wrote to the architect in Baltimore, and he says that they are not to have any traps, and that the 3-inch soil-pipe from hoppers to the large pipe is large enough. I contend that it ought to be 4-inch, and that all the hoppers ought to be trapped; and I also think that the pipe ought to continue up through the roof.

A. The system of drain-ventilation described above is similar to that carried out by Dr. Kirkbride some years since at his hospital, and in some respects similar to the device of Mr. Rand, in Philadelphia. The principle is briefly this: To create by help of a fire-heated flue a constant upward draught in a pipe which is to be connected to the house-drain, and to stop all the holes which might supply air to the drain, except those by which the drainage itself enters. Then all traps are dispensed with, except that on the main drain outside the house, and air enters the drain at every water-closet, sink, etc., to supply the vacuum created by the aspiration in the heated flue.

When this flue is kept well heated, and all parts of the apparatus are well proportioned, according to the circumstances of the case, it

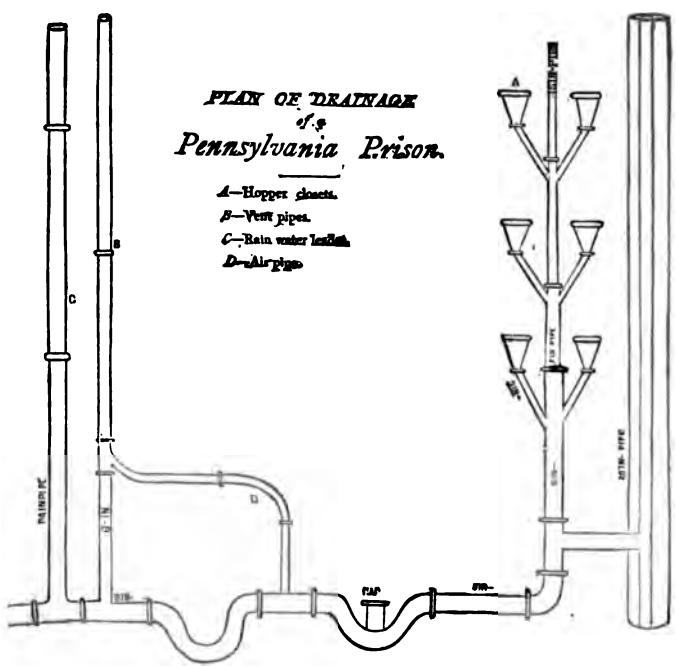


FIGURE 72.

may work well. But if the fire should be allowed to go down, or if not perfectly adjusted, the draught will be insufficient to maintain the excess of inward pressure at all points, and if it fails at any point

we have trouble at once. If the draught is weak, some of the inlet-holes will supply the whole—viz., those nearest the point where the suction is applied, while the more remote ones will not get any. This experiment was tried some time ago at the Danvers Asylum, in Massachusetts, and failed on account of the inefficiency of the draught to serve the remote openings.

We notice an unnecessary and foolish complication in the basement, where an air-pipe is arranged so that air can pass quite around the outer trap, thereby dodging it entirely. Why not omit this outer trap, and the air-pipe also, and save their cost? If the trap is really needed to stop the air from passing that point, why put in the by-pass to give it a chance to go just where it might if no trap were there?

We notice, also, that 3-inch pipes are applied as branches from water-closets to main soil-pipe. If such pipes could be made perfectly smooth, and without any offsets or inside ridges at their joints, such a small size might possibly be advisable. But with the ordinary imperfections at joints, we do not think it safe to provide less than 4-inch pipes, although the orifice at the base of a water-closet may safely be restricted to three inches, because whatever is obstructed there is within reach and can readily be removed.

In any such system which depends upon fire draughts to keep the house free from drain-gas, we must remember that the constant presence of a sufficient fire is an essential part of the scheme, and we must keep that fire burning all summer, night and day, Sundays included. In case such a fire is needed for steam-power, or any other such purpose, it may do very well; but the maintenance of a fire for this special purpose would be rather irksome, and might sometimes be neglected, with very unpleasant results. Moreover, the adjustment of the power of the draught to the sum total of all the inlets is a problem which must be worked out by actual trial in every separate case, and would vary very largely in different conditions of wind and weather, so that an apparatus which would work well during one week might be quite inefficient the next. We should not consider such a system safe, unless a large surplus draught were sure to exist at all times from a fire maintained for some purpose that *rendered it positively sure to be constant and unfailing.* The use of traps under

each sink and water-closet would be entirely inconsistent with this system of ventilation, which demands open orifices.

OBJECTION TO CONNECTING BATH-WASTE WITH WATER-CLOSET TRAP.

Q. I HAVE for some time past been troubled with a bad odor which comes from my bath-tub, the waste of which runs into the trap of a pan-closet, which is on the other side of the partition. The soil-pipe runs full size through roof and is in full view in its course through the house, and is provided with foot-ventilation outside. Three times I have applied peppermint as described in a late issue of your paper. Twice I stopped up the roof outlet after putting in the peppermint there; also the pipe at the foot in the yard. The other time I left them open, but in neither case could I find the slightest traces of peppermint.

I am confident that the soil and waste pipes are perfectly tight, yet the smell continues.

Will you be good enough to inform me through your journal what I can do to remedy the trouble?

A. It does not follow because the soil-pipe is run through roof and provided with foot-ventilation, and that all pipes are perfectly tight, that a pint or quart of peppermint would be sure to disclose the evil arising from this particular as well as many other cases of bad plumbing. We have repeatedly pointed out the danger of connecting bath or other wastes with water-closet traps.

To make the matter plain to our correspondent, and for his benefit, and in order to satisfy others who, like him, think it is all right to go and do a job like the one in question, we ask them to take a piece of tissue-paper, wet it and place it over a bath-waste—connected like the one above described—then pull up the closet handle, or empty suddenly a pail of water into the closet, and it will be noticed that the paper has been blown off by the rise of water in the trap, which displaces a portion of the foul air in the waste-pipes into the room.

If our correspondent will call in a respectable plumber, and allow him to put a trap under the bath with a vent-pipe from same and connect the waste-pipe directly with the soil-pipe, no more bad odors will emanate from the bath.

HOW TO PROTECT TRAP WHEN SOIL-PIPE IS USED AS A LEADER.

Q. WHERE a water-closet or other fixture is connected with soil-pipe also used as a leader, is there any way of securing a trap on the water-closet from siphoning when the leader is gorged with rain; or would it be preferable to disconnect it entirely? The water-closet is on an upper floor, say twenty-eight feet from the roof. The leader is 4-inch, and the water-closet trap has no separate ventilation.

A. A vent-pipe, not less than three inches in diameter, should be taken from the highest point of the trap to above the roof. In this case it should not branch into this soil-pipe.

HOW TO ADJUST THE INLET AND OUTLET OF TRAPS.

Q. PLEASE give me your idea on this subject: A claims that the pipe *b* in trap in Figure 73 should be as high or even higher than shown. He says that a current of air passing through pipe *a* will siphon out the trap.

On the other hand, B claims that in trap Figure 74, pipe *b* should be as low as shown, or even lower. Now, if the water comes down pipe *b* and goes out pipe *a* with a rush, it will not have a chance to siphon out. Who is right or wrong?

A. The ability to resist siphon-action is not in this case affected by the location of the pipe *b*, since this does not affect the amount of water in the trap, the depth of seal being apparently the same in both. It should be borne in mind that to siphon out the trap there must be a partial vacuum in the pipe *a*—*i. e.*, a part of the air has been withdrawn by the descending column of water, so that the atmospheric pressure is less on that side of the water-seal than at *b*, in which case the atmospheric pressure at *b* will force out the water until it supplies the vacuum, or what is lacking at *a*. To accomplish this the water

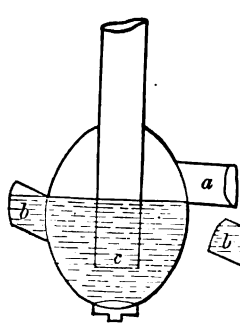


FIGURE 73.

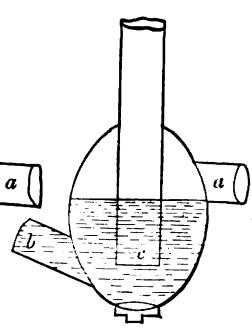


FIGURE 74.

would be forced out at *a* until it fell below *c*, so the air could pass through and make the atmospheric pressure the same on both sides. It is for this purpose that traps are vented, so that the vents may supply the air and not oblige the taking out of the water so as to get the air from the other side of the water-seal. So far as the inlet of *b* in Figure 73 is concerned, it is too high to be of much service to the fixture it is presumably intended to serve, since a slight lowering of the water-line will open direct communication between *a* and the fixture at the other end of *b*. In fact, it is not good practice to use one trap for two fixtures; each should have its own trap wherever practicable.

LIGHTNING STRIKING SOIL-PIPES.

Q. I WOULD like to have your opinion regarding the extra danger from lightning where cast-iron or wrought-iron pipes are run through the roof of a building for vent-pipes. Is there not more danger of such a house being struck by lightning? Where an iron pipe is run to the roof from a lead trap, will the lead waste-pipe act as a conductor and carry the lightning to the ground?

A. If the house is provided with lightning-rods, as every house should be, the extra danger from vent-pipes run through the roof amounts to very little, if anything. Chimneys are sometimes struck by lightning, but no one thinks of abolishing those necessary structures on that account, and the same may be said of the vent-pipe. The electrical conductivity of lead is small, only about one-half that of iron, but under ordinary circumstances, and in the case supposed, it would serve as a conductor. Joints should always be of metal, however, to avoid the mechanical effects consequent upon the lightning jumping from one conductor to another. In several cases on record more damage has resulted in consequence of a lightning-rod not properly connected than would have resulted had the rod been connected with gas or water pipes even.

WIND DISTURBING SEAL OF TRAP.

Q. SOME time ago I had the soil-pipe of my house ventilated through the roof, capped with an ordinary cowl, and the old filthy pan-closet removed.

I put in place of it an improved form of hopper-closet of all-earthenware, and had the bath and bowl wastes enter soil-pipe below closet. It is now free from smell and works perfectly, except that during heavy winds I notice that the water in closet is violently agitated and almost emptied, so as to almost break the seal of trap.

Thinking the air from sewer or soil-pipe was being forced into the house, I sponged out enough water to almost unseal the trap, and was surprised to find a strong suction into soil-pipe from the apartment.

I should like to know the cause of it, and have sketched the position of my fixtures, which are all in the rear of house and discharge into a sewer in front street about 80 feet from vertical soil-pipe, with trap outside of house, as my plumber says, but without any inlet for fresh air.

If there is a trap in drain without an air-vent, I presume the wind blowing across the cowl produces a vacuum in soil-pipe, and consequently trap of the closet is partially siphoned out; but if there is no trap in the drain, how could the wind blowing into the sewer produce similar result when the soil-pipe is open on roof, 12 or 15 feet above closet, as I am told by one party must be the cause? Could a downward draught through soil-pipe and into sewer produce such action on water-closet, and if such was the case would it not prove that there was no trap in drain? My house is located on a hill, where the wind has full sweep in one direction, and the sewer is some 15 feet deep in street. There are perforated manholes on the sewer every few hundred feet.

A. The most simple way to account for the disturbance of the water in the closet-trap is by supposing the plumber's statement to be correct—viz., that there is a trap on the main drain with no fresh-air inlet, and that the wind blowing across the cowl on the top of the house creates a partial vacuum in the soil-pipe. This is probably the state of the case.

THE EFFECT OF WIND ON TRAPS.

A condition affecting the water seal of traps was brought to light during a time of high winds. The wind attained a rate of speed equal to 83 miles an hour, and was maintained at this velocity for the greater portion of one night. As a result, the sanitary engineer has a problem presented for solution. In one of the high buildings

in New York City where no expense was spared in designing and installing the drainage system, it was found in the morning that many of the offices were filled with an odor which was both disagreeable and unusual. In this building both the soil stack and the vent stack pass through the roof separately. In a fine residence in the upper part of the city the owner, who has had considerable experience in building matters and has given some time to the study of good plumbing, reported to a plumber who usually does his work that on rising in the morning an odor that had not previously invaded his premises made its presence very marked. In this case the vent stack was connected with the soil stack above the highest fixture and previous to its passing through the roof. Another case is also reported, confirming these accounts. It was noticed that the odor did not occur after the windows had been raised and the fixtures, which were trapped, had been used so that sufficient water had been collected again to effectually seal them. In these buildings a fresh air inlet was provided inside of the front wall trap. The explanation of the breaking of the trap seal given by some experts who have discussed the matter is that under high velocities of wind there is a tendency to compress the air in places to the extent that it starts an oscillating movement of the water in the traps connected with the soil and vent pipes in buildings, and this oscillation continues until a sufficient quantity of water had escaped to break the seal of the trap. After this is done the pressure of air on the fresh air inlet, when not stopped, would have a tendency to carry the odor of the drain pipes along with it to any point of exit that could be found, and through the broken seal of the traps as well as through the outlet afforded by the vent and soil pipe stacks. Under ordinary conditions of weather such a contingency as the breaking of the seal of the traps by oscillation is not likely to arise, but it is one that is worthy the attention of the plumber and should be met by some method of effectually preventing its recurrence.

THE EVAPORATION OF TRAP SEALS.

BY P. A. D.

In discussing the length of time which the seal of a trap would be preserved under a fixture which was not in use some considerable

difference of opinion was expressed by a number of plumbers at a gathering in an Eastern city. It was generally agreed that the common S-trap under the ordinary lavatory and sink fixtures contains about 1 pint of water, and that it would be necessary to lose about half this quantity before the trap seal would be broken. In the opinion of some this quantity of water would be evaporated in the trap in as short a time as three days; others said that it would require six days, some placing the time at about two weeks. Those who were of the opinion that the evaporation would be quickly made pointed out that there were two surfaces of water which would be in contact with the air. On the sewer side of the trap the circulation through the drainage system, caused by the fresh air inlet and the soil and vent stacks, would bring constantly a current of air over this surface. It was pointed out by others that this air would in all probability be laden with moisture, and not in any condition to absorb the moisture in the trap, and would have very little influence in evaporating the water and breaking the trap seal. On the other hand, it was pointed out that even if a room was closed there would be air pressure on the windows and probably a circulation of air in the rooms, and that the air in the room would become dry by the moisture being absorbed by the walls and furniture, so that it would be in a condition to readily absorb moisture. The discussion was continued without a final agreement until one plumber stated that he had made a test by setting an ordinary drinking tumbler filled with water beside two fixtures which were trapped, and had waited until the water had evaporated to determine the time which it would be likely to require to break the seal of a trap by evaporation. One tumbler was placed on a lavatory slab in a bath-room and the other directly on the trap used under the kitchen sink. At the end of five weeks the water had entirely evaporated in each case. During the five weeks there was some weather with the thermometer above 90°, and for one week the house was closed owing to a visit being made. While the test was being made the kitchen windows were open or closed according to the weather, entirely regardless of the test. It is quite possible that water in a trap would evaporate slower and that the seal would last more than five weeks in a closed house, for the air passing through the drain would be moistened by it before reaching the trap.

A PEPPERMINT TEST.

Q. I HAVE a contract for a job of plumbing that specifies an oil of peppermint test and I would like to know how to apply it.

A. Owing to the strong pungent odor of the oil of peppermint, in a test of this kind it is safest to have two persons take part in the work. One should ascend to the top of the building, on the outside, where the vent pipe comes through the roof, provided with a bucketful of hot water and a bottle containing from 2 to 4 ounces of oil of peppermint, according to the size of the building. All the windows of the house and openings into it should be closed. The more experienced plumber should then be on the inside of the building, and at a prearranged time the workman on the outside of the building should pour a small quantity of the hot water into the vent pipe, then pour in at least 2 ounces of the peppermint, after which he should pour in the remaining quantity of hot water and cover the opening with a cloth of some kind to prevent the escape of the pungent odor. By means of the hot water the oil of peppermint will be carried down to the horizontal drainage pipe, and in a short time the entire system will be filled with a peppermint odor. If any of the trap seals are broken or the plumbing work is defective, either in the calking of the soil pipe joints or the wiping of the joints connecting the traps with the soil pipe, the odor will find an entrance, which will be detected by the plumber on the inside of the building, who should visit each of the various fixtures and lines of drain pipes in the building for the purpose of learning if there be any leaks. The greater the care he uses in his search the less will be the likelihood of any leaks in the drainage system escaping his notice. If the vent pipes have not been properly arranged, so that it is possible that the traps in some of the fixtures have been siphoned, this will be quickly learned from the strong odor that will enter the building. If the work has been properly planned and properly executed, however, the test will bring to light no defects.

MAKING A SMOKE TEST.

Q. HAVING always tested plumbing systems with a peppermint test, I have little knowledge of how to make a smoke test, and would

be glad to have detailed instructions how to proceed. Is it best to apply the smoke at the fresh air inlet or on the roof of the building? Where can the machines for making the smoke be procured? What is the best material to use in them for getting up the smoke?

A. Since the smoke test became popular in various cities of the United States a few years ago, several different styles of smoke test machines have been placed on the market, which can be supplied by any of the large plumbing supply houses. These machines consist, as a rule, of a reservoir or smoke chamber and a bellows for driving the smoke into the drainage system. The smoke reservoir has a pipe extending inside up to near the top and connected with an outlet, to which a hose is attached for carrying the smoke to the fresh air inlet or outlet on the roof, as convenience may suggest in use. Owing to the various styles of fresh air inlets greater difficulty would be met with in applying a smoke test at that point than on the roof unless the wire balls for protecting the roof pipes are securely fastened to bands and calked into the roof waste and vent lines. In either case an opening into these pipes has to be made so that the hose can be inserted, and, as a rule, wrapping with oakum is sufficiently air and smoke tight to answer the ordinary requirements. All the other openings from the fresh air inlets, waste, vent and soil pipe lines must then be closed, or they may be closed only at the time the smoke appears coming out of the different pipes.

After all these provisions are made it is time to fire up the smoke machine. This can be done by taking off the cover of the smoke reservoir and putting into it oily waste, tarred paper, or any convenient material that will make a dense smoke in firing, and with little danger of producing a blaze. Tarred paper is considered best by many plumbers. After the material is lighted the bellows is operated by the lever, sending in fresh air to continue the combustion and generate the smoke, which, by the same operation, is forced out of the combustion chamber, or smoke chamber, through the hose into the house drainage system. Care should be taken not to operate the bellows so as to generate too great a pressure after the various pipe lines have been closed, otherwise the smoke under pressure may force the seal of some trap under a sink, wash basin, bathtub or water-closet, and give the impression that there is a leak in the pipe lines in the house. If the smoke test is carefully applied and the machine operated by a careful workman, there is little danger of this

trouble. After there is evidence that all the pipe lines are full of smoke, a careful investigation should be made of each line of piping through the house, from the horizontal drain in the cellar to every vertical line and fixture connected with it. Not infrequently cracks in the hubs are discovered, and it is often found that the surface of lead pipe has not been thoroughly tinned in wiping the joint where a trap or fixture is connected with the waste line, when smoke will escape under the solder, indicating that a new joint should be made. Where nickel piping and screw fittings are used under fixtures, a broken thread or a faulty connection will sometimes show a leak.

The popularity of the smoke test has grown from the fact that when the odor of smoke is detected there is little difficulty in tracing it directly to the point of leakage, for a close investigation will show the smoke puffing through the crack or opening at each movement of the lever of the smoke test machine, while, with the peppermint test, the exact location of the leak is often difficult to find. Cracks in rusty cast iron soil pipe that are not readily discernible to the eye will let little jets and puffs of smoke escape that can be readily seen, and the same is true of improperly tinned lead piping, where wipe joints have been used. Again, great care has to be taken in peppermint tests so that a leak in one room will not penetrate and give the impression that it is in another, while where the smoke test is applied no inconvenience to the family is necessary. The house can be used just as if no test to the drainage system was under way.

GREASE CHOKED PIPES.

WASTE pipes leading from the kitchen sink are a frequent source of annoyance to the housewife, owing to their becoming stopped, as every plumber is aware from his being called in to clear them. Observations on this subject by one who has had so wide an experience as H. A. Desper, of Worcester, Mass., will be of more than ordinary interest. He points out that the stoppage is often due to the fact that the liquids which are used in cooking various kinds of meats, particularly those of a greasy character, when poured into the sink, offer opportunity for the grease to harden on the sides of the waste

pipe as it flows through, gradually decreasing the bore, until under some circumstances the pipe is entirely stopped. Ordinarily, this grease will adhere to the sides of the pipe on a line with the level of the water as it flows through, and in some cases will extend almost to the center of the pipe from the sides. When this happens, it is not infrequent that a quick discharge of water into the pipes is liable to break off a piece of this hardened grease several inches in length. This is carried further along the pipe and is either broken by the flushing process and discharged, or lodges and facilitates the accumulation of grease until the pipe is fully stopped. The manner in which the accumulation is formed is partially shown in Figure 75. The bottom of the pipe is shown stopped with both grease and sand, the sand having been washed from the sink in the preparation of vegetables for cooking and from washing articles that have an accumulation of grit on them. The sides and upper portion of the pipe are covered with grease, which has floated on the surface of the water and which has splashed up against the top of the pipe as the water flowed through until it was effectually stopped. The liability of stoppage in pipes very materially increases with a fall of temperature out of doors. A pipe that is partially stopped is liable to have the grease very much hardened; and on account of being at a low temperature the water discharged is liable to become very cold before reaching a point where the bore of the pipe has already become materially reduced. The grease which is in the water is already in a semi-hardened condition and ready to adhere to whatever projection or obstruction it may come in contact with.

FIGURE 75.
Sectional View.

FIGURE 76.
A Waste Pipe Cleaning Wire.

It has been recommended by some that a strong solution of lye or potash be poured into the sink pipes at least once a week, with the idea of preventing any considerable accumulation of grease on the inside of the pipe and to decompose that which may have already be-

come deposited, so that it can be flushed out. Previous to the use of the potash the pipe should be thoroughly flushed and warmed with hot water. This practice may possibly prevent the accumulation of grease; but after the accumulation has been made the effect of the lye is to decompose the grease and leave a substance within the pipe of a more or less porous chalky nature. Should this material be washed off the sides of the pipe by a flush of hot water it is liable to cause stoppage further on. Some plumbers who have been called in to remove such stoppages have been more or less burned by the escape of this strong solution of lye when they opened the pipe to remove the obstruction.

FIGURE 77.

A Grease Choked Vent.

Of all the villainous stuff a plumber gets his hands into none surpasses the mixture of potash and lime in solution that fills a trap or pipe that it is supposed to open. It will turn the finger nails a chestnut brown that will last a week before fading out, and woe to the one who has scratches or the skin broken on his hands, for it is liquid fire to them. In one case where the sink pipe in a new house was stopped up within three weeks after the house was occupied by a tenant it was found that the cook was frying doughnuts, and that the grease, catching fire, scorched sufficiently before the fire could be smothered to spoil it for cooking purposes. This grease was poured into the kitchen sink; and it is not strange that a stoppage was reported shortly afterward.

The most successful method employed for removing hardened grease from sink pipes is to put in a clean out screw at some convenient point, insert a wire or rattan, loosen the grease and remove it.

A good plumber will always use a clean out screw and will never slit a pipe except as a last resort, for after slitting and opening a pipe it is impossible to close it up so as to make it smooth on the inside. With the greatest care and best workmanship, the rough edges will collect crumbs and grease and probably cause another stoppage.

The greater the care taken by the plumber in doing this work the better will be the condition of the pipe when he is through. Figure 76 shows a spirally bent wire coil made of telegraph wire fastened to a long piece of wire, for use in clearing out the grease choked pipes. The coil can be made largest at the center and tapering toward both ends with advantage. Being flexible it is readily inserted through the clean out, and if made with a hook can be used for pulling a swab.

When pipes are partially stopped there is liability of the vent pipe filling with grease through the backing up of the grease laden water from the sink, and even when the pipes are entirely free the rush of water through the trap will often spatter grease up the vent pipe until it is clogged. An illustration of this is shown in Figure 77. Mr. Desper has in his possession a trap with vent pipe attached and stopped as described. Sometimes this grease will reach up to a point level with the top of the sink. The fact that this pipe does not have the advantage of being flushed adds to the probability of its being stopped and its efficiency in preventing the siphonage of the trap entirely destroyed. If a union was placed in this pipe at a point higher than the sink, it could be disconnected and easily cleaned. In Worcester, Mass, the city regulations permit the vent to be attached to the waste pipe as much as 16 inches away from the trap proper, measuring on the inside of the pipe from the water in the trap, the connection with the waste stack being made by means of a Y, as shown in Figure 78. By this method the probability of the greasy water splashing up into the vent pipe and stopping it is very much reduced. A modification of this method of back airing the sink pipes is capable of a wide application in connection with kitchen sinks.

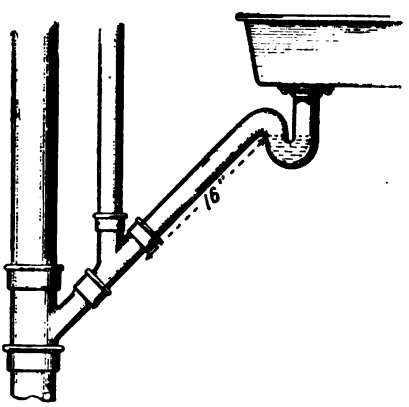


FIGURE 78.

A Vent Connection to Prevent Choking

AN OBSTRUCTED SINK SPOUT.

A COUNTRY TINNER was called to a house to see about a sink spout that had become stopped up. The trap screw was taken out and the dirt contained in the trap made to move on by using a small wire. After this operation had been performed it was supposed that water would run through the pipe, but such was not the case. There was about 3 feet of horizontal pipe under the kitchen floor, and this part of the pipe was perhaps where the trouble was. A short piece of rubber pipe, such as is used on perfumery bottles, was found, and after the sink strainer had been taken out, a rag was wound about the rubber tube, and this combination inserted into the sink pipe. By blowing into the rubber tube with great force a number of times, a slight impression was made on the mass below.

The next step was to pour some hot water into the sink spout and then blow again. After this operation had been repeated a number of times the water would run out slowly. The opening in the sink pipe was then closed up and the sink filled with water, and as soon as the plug in the pipe was withdrawn the water started out in great shape. The pipe was then given a good dose of ammonia, when more hot water was poured in. This was done to remove the grease. To perform the operation described above, it is necessary that the tinner should be provided with at least a piece of rubber pipe and a set of strong lungs.

THEORY OF A GREASE TRAP.

Q. WILL you give me some advice concerning grease traps? I am to fit up a hospital soon and a kitchen sink is desired, but there is a fear that grease will stop the sewer. Figure 79 shows the simplest trap I know, though in this case cost is less important than a trap that does the work and does not get out of order.

A. Figure 79 shows the principle observed in grease-trap construction. The idea is to provide a trap large enough to receive a considerable discharge of greasy water and hold it till the grease has risen to the surface, where it is held until removed, leaving the water below practically free from grease. The water line in the trap is maintained above the outlet by running the outlet pipe down below the water line and near the bottom of the trap. This allows the clear

water at the bottom to pass off without leaving any deposit in the sewer whenever the trap receives a new discharge. The trap tends to cool hot water and harden the greasy accumulation, which floats on the water and is held until the cover is taken off the trap and the grease removed. Frequent cleaning will avoid the possibility of the

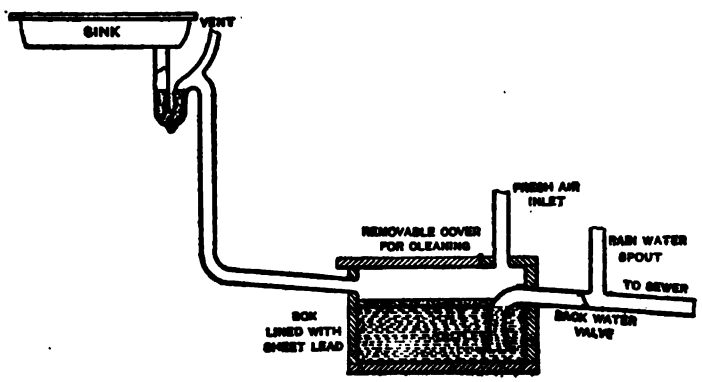


FIGURE 79.

Theory of a Grease Trap.

hardened grease being flushed through the trap or odors arising. The cleaning will be more certain and frequent if care is taken to locate the trap where it can be done with ease. To vent the trap as a precaution is commendable, though not generally done, as the cover is supposed to be air tight.

A GREASE TRAP AND SIPHON CHAMBER.

BY W. B. GRAY.

AFTER the yard has been filled and graded around a country house to make the terrace high enough, it is necessary to put in iron, soil and waste until firm ground is struck. You first run 4-inch iron soil-pipe to firm ground, then put in a hand-hole earthenware running trap, a fresh air inlet pipe is placed on the house side of the seal and a foul air outlet pipe on the vault side. The trap is not placed until firm ground is struck, because iron running traps, on account of the shape, are liable to be broken by settling, just the same reason why stone pipe was not started outside of the foundation wall. First-

class salt-glazed stone pipe is continued from trap to vault, with all the fall obtainable without entering the vault too low, and not less than ¼ inch to the foot. The soil vent is capped with a ventilator, which induces a current of air through the soil-pipe no matter which direction the wind blows from, and does not interfere with the vacuum being replaced, which is caused in soil-pipe when the closet is used. Next, an air-pipe is placed in the main bath and kitchen-sink waste some distance outside the house. When firm ground is found you commence with 3-inch earthenware pipe and continue to grease trap, Figure 80, in connection with siphon chamber used to secure intermitting discharges to the absorption tile. In this manner, the irrigated ground has a chance to filter the liquid, the filtered liquid soaks away into the earth, leaving the matter behind which is oxidized by the oxygen of the air penetrating the soil before another discharge. The siphon chamber should not be too large to prevent it from siphoning once in 48 hours at least. Figure 81 shows a cross-section of the ground in which grease-trap, siphon chamber and absorption tile are placed.

The absorption tile is in 12-inch hubless lengths, 2 inches in diameter, and perforated with little holes. It should be considerably less in capacity than the siphon chamber, or the entire system will not be filled by the discharge of the siphon chamber, because some of the water is taken up by the earth before the chamber is through discharging.

The pipe leading from the chamber to the absorption tile is glazed and cemented tight at the joints. The absorption tile lines are cemented shut at the ends.

You have no earthenware pipe supports or hoods at hand, consequently you do the best you can under the circumstances—that is, lay some old cedar boards along the bottom of the trenches, about 12 inches under the surface; then place the tile and cover the joints with half rings of the stone 4-inch pipe, left after finishing the soil sewer to vault. These rings should be cut about 4 inches long and placed as shown in Figure 82. In Figure 81, A is sink and bath waste; B, air inlet; C, absorption tile, and E, overflow from siphon chamber.

A description of Figure 80 shows the grease trap and siphon chamber of a country job. The chambers are made of good brick, laid in cement mortar and plastered inside. They have arched tops, fitted with iron cistern plates and rings, K K, to afford access for cleaning and inspection. The grease trap is made the same depth as

the siphon chamber for two reasons, first, because it makes a better foundation; secondly, because it insures that the grease will come to

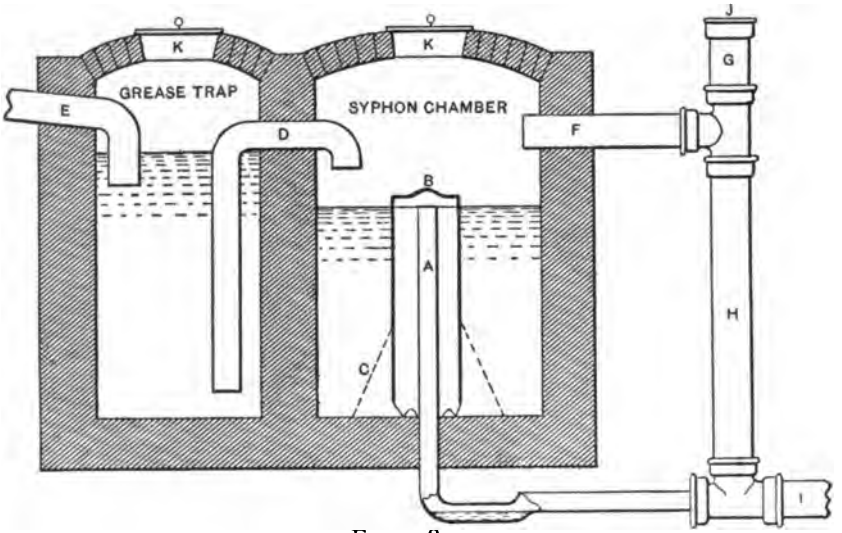


FIGURE 80.

Section through Grease Trap and Siphon Chamber.

the surface without going deep enough to get into the siphon chamber through the transfer pipe. The inlet pipe E to grease trap from house has a hole in the crown of the bend to prevent discharges from the house getting air-bound, after the grease trap gets full enough to seal the end of the inlet pipe. D is the overflow pipe to siphon chamber. B is the bell or hood with toothed bottom edge, and forms

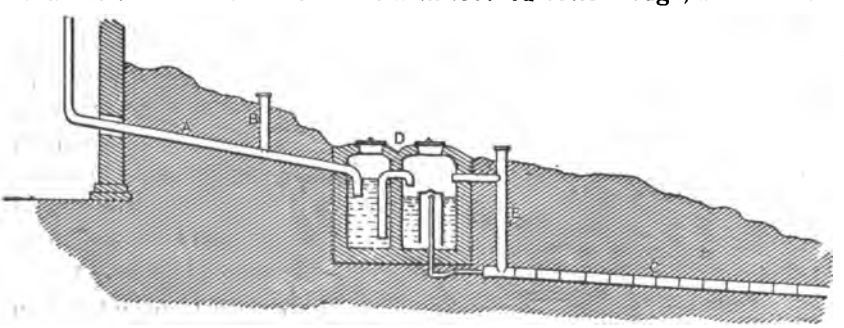


FIGURE 81.

Section through Ground, Showing Grease Trap and Absorption Tile.

the outer leg of the siphon. C is a cape of wire mesh fastened about the bell to prevent any possible chance of the siphon becoming

clogged. A is the inner leg of the siphon, and is nearly trapped at the bottom, which allows the concussion, after a discharge of a tub of water when the siphon is ready to act to seal the pipe A and start the siphon; it then continues to act until empty. When the siphon chamber is ready to act, any considerable inlet of water causes a flow over the top of A from every point of its circumference, which catches and forces down air with it. This creates a partial vacuum in the top of the bell. The overflowing water comes in contact with that in the bend of the inner leg and seals it. The velocity of the whole continues to rarify the air in the space between the part sealed in the bend and the seal made by the outer leg until water takes the place of the air in the top of the bell. There being no reason why water should hang anywhere where there is unequal pressure on its surfaces; the water in the top of the bell drops into A until A is completely filled. The gravity of both inner and outer legs of the siphon are now equal in pounds per square inch from a line on the bottom of the cell up, but the weight of the water from the bottom of the chamber down in the inner leg keeps pulling the water above the bottom in the inner leg downward by reason of the tendency of some particle of water to cling to another. This loss is supplied by the atmospheric pressure feeding the outer leg of the siphon from the chamber until it is empty or below the teeth of the bell when air gets in, breaks the column, and allows the water above the level of the chamber water in the outer leg to run back in the chamber.

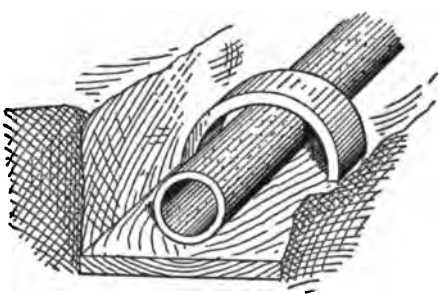


FIGURE 82.

Showing Method of Laying Tile

F is the overflow from siphon chamber.

G, air-pipe.

J, strainer in air-pipe.

H acts as overflow and air-pipe combined.

I is the leader to the absorption tile.

COLD WATER SUPPLIED TO A GREASE TRAP.

Q. WILL you kindly inform me what is the object of a cold water supply to a grease trap? Is not the waste water sufficient?

A. It is quite general for greasy water to be discharged into a kitchen sink at a high temperature, and the object of a grease trap is to harden the grease on the surface of the water in the trap. If a considerable quantity of hot greasy water was discharged into the trap it is more than likely that the hardened grease in it would be melted and carried into the waste pipes and choke them, thus frustrating the design of the grease trap. By connecting a cold water supply pipe to the grease trap a cooling surface is provided to prevent the hot water from melting the grease that may have already hardened on the surface of the water and to cool the hot greasy water that is discharged into the trap so that the grease which it may carry with it may be hardened and kept from passing through the waste pipes. A grease trap without a cold water chamber surrounding it would have to be of large size to be of benefit. By the use of a cold water chamber a much smaller size trap is practical and efficient in service.

AN ACID PROOF DRAINAGE SYSTEM.

IN a large building in New York where a number of silversmiths and manufacturing jewelers were tenants it was found that the cast iron soil pipes in the building became eaten through owing to the discharge of waste acids into them. In order to overcome the trouble an acid proof drainage was put in. On examination it was found that the holes eaten in the cast iron pipe were just above where the liquid entering the vertical pipe from the Y-branch would splash against the pipe. In the new system an independent line of lead pipe has been run to receive the discharge from all tanks, vats or barrels in which acids are used by the various manufacturing tenants. The old iron soil stack has been repaired and still serves its legitimate purpose. All of the lead pipe and sheet lead for lining the diluting tanks in the new system is of the quality made especially for chemical work.

All joints, seams and connections in the lead are made by the lead burning process. A 3-inch heavy lead pipe runs from the top floor, with branches burned into it at the different floors to receive the discharge from the tanks. In the basement this pipe discharges through diluting and mixing tanks into the main drain pipe, which is extra heavy cast iron. In order to dilute the acidulated discharge from the lead pipe before it entered the main drain, so that its strength would not be sufficient to do harm or eat the iron, a system of diluting and mixing tanks, shown in Figure 83, was designed.

These tanks were earthenware slop sinks, and to prevent splashing were lined with sheet lead and had a sheet lead cover burned on, and having in the top hand holes for cleaning. The 3-inch pipe was run through the cover and nearly to the bottom of the diluting tank, a tight joint being made by lead burning. A 2-inch pipe was carried through the building out of doors to serve as a vent to prevent the tank becoming air bound. A ½-inch water supply pipe was connected with the cover by lead burning, and a cock placed on it so that a small stream of water could be kept continually running into the tank to dilute any discharge into the tank from the 3-inch pipe. In order to still further dilute the contents of the tank a 1¼-inch flush pipe connects with the cover leading from an automatic flushing tank on an upper floor. By this means enough water to thoroughly flush the tank is automatically discharged into it at regular intervals, governed by a set cock. To insure a mixing of the liquid the tank is emptied by a siphon into another tank, from which a pipe is carried to the main drain. This method of diluting the acidulated discharge is expected to prevent the destruction of the cast iron pipes.

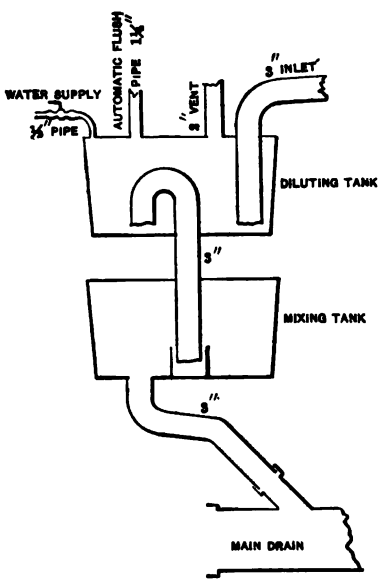


FIGURE 83.

An Acid Proof Drainage System

WATER-CLOSETS AND HOUSE FIXTURES.

SELF-ACTING WATER-CLOSETS.

Q. WILL you be kind enough to help a young man who is puzzled? I would like to find out how to rig up a self-acting water-closet, one that will flush when the door is opened. I do not understand how the cranks and valves are arranged.

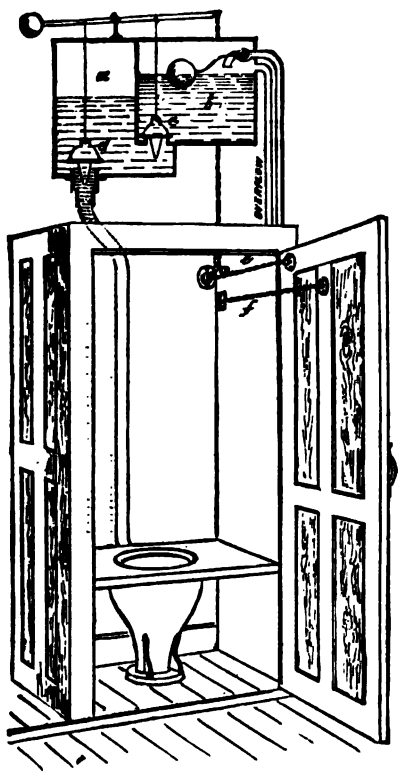


FIGURE 84.

a—Measurement compartment.

b—Storace compartment.

c and *d*—Valves.

e—Chain by which the door opens and closes valves.

f—Door-stop.

A. The above sketch will give you an idea of how to arrange a chain to work the valves in a cistern to flush a water-closet. This shows a cistern directly over a water-closet, but when it must be located elsewhere, it can be made to work by using more pulleys. The chain *f* is to act as a door-stop, in order to prevent opening the door so wide as to break the chain *e*. It will be noticed that we have, for

the purpose of illustration, selected the kind of waste-preventing cistern approved by the New York Board of Public Works. The door should have a spring on it to keep it closed.

In such situations a waste-preventing cistern is desirable, so that if the door is held open, only a limited amount can be drawn off.

HOW TO ARRANGE HUSH-PIPES IN CISTERNS TO PREVENT SIPHONING WATER THROUGH BALL-COCK.

Q. A MONTREAL correspondent objects to a hush-pipe in water-closet cisterns, as it forms a siphon when the supply-pipe is full. Will it? He recommends fitting the ball-cocks above the water and using a deafening-pipe, the construction of which I do not understand; what is it?

Would it not be desirable, if water-supply were abundant, to have a constant light flush for water-closets, thus tending to keep the soil-pipe freer from foul deposits, and would not such a flush offer an obstruction to ascending sewer-gas that might form in the house drain?

Will you briefly recapitulate the reasons why a rain-water conductor should not be entered into a soil-pipe?

Do you think it desirable to ventilate under the seat of a water-closet when the plumbing is well trapped and otherwise well ventilated? There would be very little odor, and that might be removed through the ventilating system provided for the room.

What is a bidet?

A. In some circumstances we think the danger of siphoning, to which the correspondent's letter referred, might exist, and it is therefore desirable to fit up the ball-cocks, as he recommends, above the surface of the water. The "deafening" or "hush" pipe is a pipe fitted to the ball-cock and carried below the surface of the water in the cistern, so that the cistern will fill noiselessly, the discharge taking place under water, and open at its upper end so it can serve as the short leg of a siphon.

A "constant light flush," if we understand you aright, would be useless, for a driblet of water does not wash away anything in its course. Nothing can be useful for flushing short of a body of water that would completely fill the drain-pipes.

A rain-water leader should not enter a soil-pipe by a tight con-

nection, because it is difficult to keep its trap supplied with water during a dry time, and, if not so trapped, the chamber-windows may receive the air from the drains or sewers through the upper end of the leader or through leaky joints. It is better to connect the rain-water leaders with the drain over the main house-drain trap, just outside the house, where the rain-water can pour into a tunnel in the manhole-chamber, by which access is had to this trap, and without a closed connection.

A good air-draught from under the seat of a water-closet is a desirable thing, but not so essential to health as many others. It is better to remove disagreeable odors directly at their source than to suffer a whole room to be tainted by them, and trust to any general ventilation of the room, the proper operation of which would require one hundred times as much air to be removed as is required for the special purpose referred to.

A bidet is a small bath-tub used in bathing parts of the body when a complete bath is not wanted.

TWO TRAPS TO A WATER-CLOSET OBJECTIONABLE.

Q. I DESIRE a little information in regard to a method (proposed to me by my plumber) of connecting the waste from wash-basin and bath-tub with that from water-closet *before* piercing the main 4-inch iron soil-pipe. He proposes to trap both basin and bath-tub separately (the traps being ventilated to the roof) and to unite these waste-pipes below the traps and carry the waste into the upper part (*above* the water-line) of a large trap situated just *below* the trap of a Jennings all-earthen closet. Both the earthen trap of the Jennings closet and this large lead trap are to be ventilated to the roof. In this case you will observe that all three wastes are separately trapped and ventilated, and that the united waste passes into another trap, also ventilated, before discharging into the main soil-pipe. Is this arrangement good from a sanitary point of view?

Another question: The ventilating-pipes from these different traps just referred to he proposes to *unite* at convenient points *above* the level of the traps, and to carry the whole in one into a 2-inch ventilating-pipe and thus to the roof. Is this arrangement as good as to pierce the 2-inch pipe in four different places for the separate ventilating-pipes, and thus ventilate to the roof?

A. In answer to the first query, we should say that, assuming that each fixture is separately trapped and properly ventilated, the

advantage of the large trap just below the water-closet trap is not apparent. On the other hand, we consider such a trap as objectionable, for the reason that it retards somewhat the flow of waste matter without securing any adequate advantage as an offset for its being there. From the question as it stands, and in the absence of a sectional drawing, we should consider the several fixtures, trapped and ventilated as described, as amply protected, assuming, of course, that the house-drains are otherwise all right. A needless trap is an injury rather than a benefit.

Secondly—As we understand your last question, we should say that the choice of methods was simply a matter of convenience and economy in the use of pipe, provided that the 2-inch pipe was used solely for ventilation and received no drainage.

SETTING SIPHON JET WATER-CLOSET.

ASSUMING that one closet is to be placed in the bath-room of a private house, with only the bath-room fixtures on that stack, the stack should be run up through the roof so that the part above the fixtures may be used for ventilating the traps. In selecting the Y which must be put in the stack to receive the closet waste, it must be decided whether the bath and lavatory waste are to be connected to a separate opening, as special Y's are now on the market adapted to this method, which represents the best practice. In determining just where this Y must be placed, the workman must know whether a marble slab is to be used under the closet, and if the bath-room floor is to be concreted or made of matched flooring, and also the depth of the joists. As there is a trap contained in the vitreous ware closets it is only necessary to provide a lead bend to connect the closet with the Y, but this connection is the most important part of the work, for if it leaks water and filth it is a nuisance, and worse yet if it leaks the filthy air of the house drains and possibly air from the sewer. No

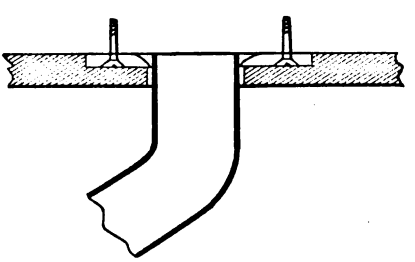


FIGURE 85.

Setting Siphon Jet Water-Closet.

more need be said to show that this connection must be made with conscience as well as with the usual plumbing materials.

At one end of the lead bend a heavy brass ferrule should be connected by a stout wiped joint and then securely calked into the Y. At the other end of the bend a brass floor flange should be attached by a good soldered joint, as shown in the sketch, care being taken to thoroughly tin the bevel edge of the countersunk floor flange before attempting to do the soldering. Bolts are furnished for fastening the earthen part down tight to the flange. In order to make the joint tight some use a rubber gasket that is said to be pure, but it does not remain undefiled long if used. Many prefer a good red lead putty, for it has the property of lasting indefinitely.

Owing to the trouble with broken vent horns on all earthen closets it is better to vent the trap by means of a branch at the lead bend. This takes an obstruction out of the bath-room, and if this branch is carefully made there is little danger of its being choked. The other end should be carried up to a sanitary T placed in the stack above the highest fixture. Put a rubber connection on the flush pipe, as then there is no danger of breaking the horn. Get dimensions of the closet from the dealer and measure the place where the work is to be done, so that a working drawing of the whole job can be put on paper in plan and elevation before the work is commenced.

PROPER SIZE OF WATER-CLOSET OUTLETS.

Q. WILL you please inform me what you consider the proper diameter (interior) for a water-closet trap? I find many of the closets of recent make contract the diameter of the trap to *three* inches, or even less. While a pipe of this diameter has the advantage of more thorough scouring at every flushing, and might prevent many things from entering the soil-pipe which have no business there, would it not be liable to be clogged when large or stiff paper is used, especially in public places? On the other hand, if the diameter of the trap is too large, the body of water to be moved is heavier, the scouring less, and, where 3-inch soil-pipes are used, as is now occasonally seen, danger of obstruction therein is greater. For hopper-closets should you consider 3½-inch a good dimension?

A. As 4-inch seems to be the size of soil-pipe most used, it is desirable that the outlet of a hopper or water-closet should not ex-

ceed 3½ inches. With good flushing, we do not apprehend any trouble from stoppage, even if the outlet is only three inches.

THE EFFICIENCY OF SEAT VENTS.

Q. WILL you kindly inform me if seat ventilation is practical—that is, at the top of the closet seat?

A. Being a plumber I want as good a plumbing system in my own house as I can get, consequently to my closet seat vent I connected a 2-inch pipe, running it to the kitchen chimney. In my opinion it has always worked well, there being no odor after using the closet. I knew of no way to test the vent, and so was not absolutely sure of its usefulness. A short time since, however, I had an order to put a closet with seat ventilation in a small room. Not having a closet with a vent on the right side I ordered one, and after waiting two weeks for it I could wait no longer, and to accommodate my customer took out the closet from my own house and put in its place a closet without the seat vent. After using it there was always an odor in the room. It is not often that one has such a practical test, and I am now thoroughly convinced that seat ventilation is effective. In another house I put in a closet, and as I could not connect the seat vent with the kitchen chimney I thought it would be of no use, but finally, as the closet was in a room off the hall without a window in it, I ran the seat vent pipe out through the roof, putting a 2-inch globe ventilator on the top, and it has worked as well as any I ever put in, there being no odor whatever in the small room, which is without a window to otherwise ventilate it and keep the air pure.

CONNECTING BATH-WASTES TO WATER-CLOSET TRAPS.

Q. WE have a job of work which was done according to the inclosed plan. We would like you to inform us, if possible, why it is that there should be a smell of sewer-gas through the bath-tub pipe. A is the soil-pipe, which is extended through the roof; the sewer in

the cellar is carried to the chimney, and run up next to a hot flue to the top of chimney. B is a 2-inch vent-pipe from closet-trap. C is a plunger-closet, with a trap. D is a lead trap under the trap of the water-closet. E, waste-pipe from bath-tub to water-closet trap, which is taken out above the water-line. F is the 1¼-inch vent-pipe from the bath-tub trap. G, overflow of bath-tub where the sewer-gas smell is the strongest. H, waste from bath-tub, through which there is some smell. I, bath-tub. None of the traps siphon out, for we have tried them thoroughly. Almost instantly after pouring in water the smell comes up through the opening H and I. We would like very much to have you explain, if possible.

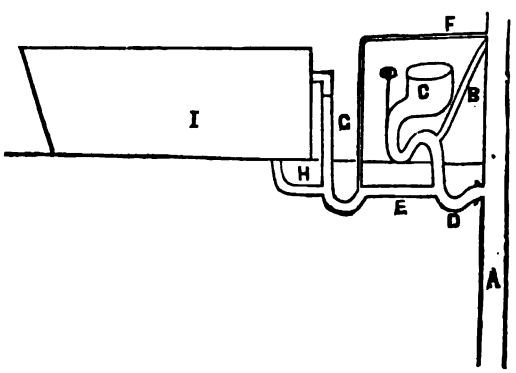


FIGURE 86.

A. The overflow-pipe does not seem to enter the dip of the bath-tub trap, which permits a circulation of air down H and out at G, or *vice versa.* The smell, you will doubtless find, is caused by the fouling of the overflow-pipe. It is possible this smell is produced by servants rinsing out bedroom vessels in the bath-tub. Heat a flat-iron and place it against the overflow, and see if you can detect a smell of urine. It is, of course, presumed that no drainage enters the soil-pipe A above the vent-pipes B and F.

On the foregoing reply a correspondent writes:

"While you suggest a probable cause, I don't think you go far enough. In the first place, the person lifts the handle of the water-closet, which has a large body of water discharging instantly into the soil-pipe. This heavy plunge of water drives the air before it with such a pressure as to force the confined air (between the trap of water-closet and the trap D, shown on the plan) through the trap of the bath. As the air-pipe from the bath-trap, under the circumstances, is entirely too small to allow the compressed air, caused by discharge of water-closet in the confined space between the two traps, free vent, it therefore finds vent through trap of the bath, the waste

of which appears on the sketch to be larger than the air-pipe from the same.

"The proper remedy is to take the lower trap D out entirely, and give the soil-pipe of the water-closet a free vent into the main sewer. What the plumber put the lower trap in for is beyond my comprehension, and the sooner it is removed the better. I presumed, as you did, that nothing empties into the soil-pipe above the vent-pipes F and B, for in that case the vents would be of no use whatever, as they would, in all probability, be stopped up by slime and filth."

We quite agree with our correspondent that the lower trap D should be removed, and his theory of the cause seems reasonable, although similar complaints are frequently made, and the cause has been traced to the source indicated. As this particular style of water-closet holds only 1⅛ gallons of water, and that is discharged through a side-outlet 3½ inches in diameter, consuming a little time in its delivery, it is a question whether the vent-pipes F and B, 1¼ and 2 inches respectively, the compression of air could be so sudden as to greatly displace the water in the bath-tub trap. Moreover, the space between the two traps, ventilated as shown, and frequently flushed, could hardly be as foul as our correspondent intimates. The lower trap, however, should not be there, and it was a neglect on our part in not advising its removal.

NUMBER OF WATER-CLOSETS REQUIRED IN A FACTORY.

Q. In putting in water-closets for a large factory in an Eastern city, employing in one large building perhaps 300 hands, about one-half of whom are women, the question arose how many water-closets would be needed. Will you please inform me whether sanitary engineers have adopted any ratio for such or similar cases? I have thought that perhaps your city Board of Health may have considered the question in connection with your densely-populated tenement-houses, and, if so, would like to know their regulations in the matter. Also, whether under such circumstances, as all the closets will be on one soil-pipe—*i. e.*, arranged directly over one another in a shaft or annex, and will be flushed with 2-gallon flushes from cisterns—a 5-inch drain-pipe, iron, running some distance, with a fall of one in forty, will be sufficient to take care of the wastes and occasional foreign bodies thrown in by carelessness, without risk of obstruction.

A. We think you would require at least sixteen water-closets—eight for each sex. The pipe proposed is large enough. It should be provided with hand-hole screws to admit of the removal of obstructions. You do not state how many operatives will be employed on each floor. One rule would be to provide at least one closet for each twenty operatives on a floor.

CLEAN EARTHENWARE.

IT IS the custom of a plumber who has a large trade in residence work to always see the mistress of the household previous to turning over a completed plumbing job for the use of his customer. It has been his experience that many of the offensive smells which are reported are not due to defective plumbing, but to negligence on the part of house servants to maintain proper cleanliness of the sanitary earthenware fixtures in the building. He makes it a point to explain the internal construction of all the earthenware used and the manner in which it is liable to accumulate matter which will produce offensive smells and present a disagreeable appearance. In his opinion the care in providing a strict cleanliness in the earthenware used in sleeping apartments previous to the advent of the water-closet should be observed in looking after the modern water-closet and lavatories. He also informs them that in case of any accumulation on the surface of the closet bowl it can be removed by the use of muriatic acid diluted with water and applied by means of a swab made by wrapping and fastening an old cloth around a stick. The same care should be observed in the sanitary fixtures found in restaurants, hotels and other public places. It hardly requires a second thought to know that ordinary flushing devices are not capable of thoroughly cleansing the earthenware surfaces exposed, and that if the proprietor was informed of the proper manner of caring for these fixtures they would be kept in better condition or the plumber would be called into service occasionally to thoroughly clean them.

DRY CLOSET SYSTEMS.

Q. PLEASE inform me whether the dry closet system is a success? In our town we are building a $16,000 school building and are considering the use of a dry closet system in the building; but there

are a number of citizens who think it is not the right thing, and we would like to have some ideas on the subject.

A. There can be no doubt that the general custom of using water-closets is regarded by the public as evidence of progress in sanitation, and that dry closet systems are not looked upon as the highest type of modern school-house equipment. A dry closet system can be devised and installed by competent engineers so as to present but few objections, but there is always a risk that the cheapening process and the incompetency of those who have charge of the work may lead to the construction of something, which, if not positively detrimental, is at least not worthy to be classed with the average water-closet system for sanitary effect. In many instances the flues from dry closet systems have been so arranged that the foul air is drawn into the building through the air supply of vent flues, or escapes from the rooms in which the closets are located and is drawn through the building, as a result of the ventilating system provided. The movements of air are not as thoroughly understood by those who install the dry closet systems, as when a separate contractor installs the heating and ventilating systems, and there is likely to be a conflict of air currents, with the result of the building having a strong infusion of air that is not conducive to the health of the occupants. Where there is so much risk to run and where the purity of the atmosphere is so essential, it is far better to prevent possible complications by using a water-closet system, which is far less likely to contaminate the air in the building than experience has shown the dry closet system to be.

SIPHONS AND SIPHONIC EFFECT

TRICKS AND MANNERS OF SIPHONS.

BY L. ALLEN.

To understand some of the anomalies in the action of siphon pipes for conveyance of water, a reference to the principles on which their action is based is necessary. All the more is this needed because the text-books that treat of siphons usually omit to speak of more than one principle, whereas there are several.

A good example of the usual mode of treating this subject is the following, from "Ganot's Physics," a treatise of high reputation and widely used in schools. The whole discussion given in this work to siphons of constant flow occupies less than a page, including

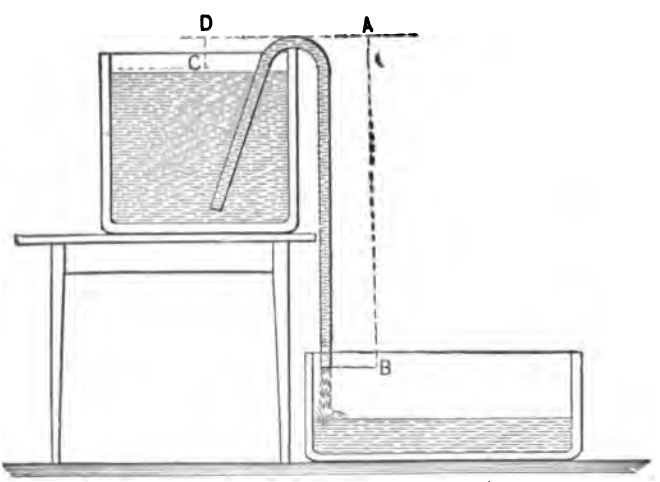


FIGURE 87.

View of Siphon.

two cuts used as illustrations. A short paragraph on intermittent siphons is added, and the subject is then dismissed.

First, a definition of a siphon is given as "a bent tube, open at

both ends and with unequal legs." The word "leg," as applied to siphons, is left undefined, but the context must inevitably lead the reader to infer that the two parts of the pipe joined at the bend are what is meant by legs.

How a siphon is used for emptying liquid from a vessel is then described, that is to say, how to fill it and place in the vessel. By means of a cut substantially like that herewith given in Figure 87 the adjustment of the siphon is shown; then there are 11 lines of explanation, which I quote *verbatim*:

"To explain this flow of water from the siphon, let us suppose it filled and the short leg immersed in the liquid. The pressure then acting on C (surface of liquid) and tending to raise the liquid in the tube, is the atmospheric pressure minus the height of the column of liquid D C. In like manner the pressure on the end of the tube B is the weight of the atmosphere less the pressure of the column of liquid A B. But as this latter column is longer than C D, the force acting at B is less than the force acting at C, and consequently a flow takes place proportional to the difference between these two forces. The flow will therefore be more rapid in proportion as the difference of level between the aperture B and the surface of the liquid in C is greater." This is the whole story. The writer has looked in many treatises for a better exposition without success. To show how inadequate it is, a modification of Figure 87 is herewith given, and, without violating any definition, principle or direction laid down by Ganot, an inoperative siphon may be constructed.

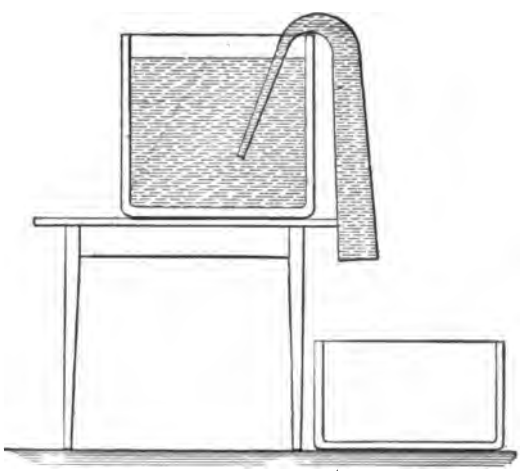


FIGURE 88.

Inoperative Siphon.

In Figure 88 every detail is shown substantially as set forth by Ganot, except that a trumpet-shaped tube is used, having its smaller

inflow and outflow shall be equal, a careful study of these diagrams is recommended.

As with muddy water the clogging of a siphon by silt will be less when the velocity of inflow is small than when the velocity is great, it is always wise to use at the inflow end several lengths of pipe considerably larger than the remainder of the run, whenever the source of supply is subject to becoming soily from any cause.

To prevent any misunderstanding, it is added that without respect to the actual length of pipe extending either way from the highest point in the pipe, the longer leg is always on the discharge side relatively to that point; or, to put it in another way, the longer leg of a siphon is the one that has the greater vertical height from its mouth, as measured from its mouth to the level of the highest point in the pipe.

SIPHONIC ACTION AND HOT WATER.

BY PLUMBER.

ANY ONE interested in the subject of siphons and the result when atmospheric pressure is removed would do well to try this simple experiment. Use a half gallon bottle for a boiler and put two ⅛-inch copper tubes through the cork. Then place the bottle on a work bench, as shown in the sketch. Before putting the cork in the bottle attach a piece of hose or rather small rubber tubing to one of the copper tubes to answer the same purpose as the delivery tube in a boiler. Then connect a short piece of the rubber hose with the outer end of the same copper tube, and to the other end of the hose attach about 3 feet of the small copper tubing bent to form a siphon. To the other copper tube in the cork attach a piece of rubber hose about 6 inches long. With a basin of water and this latter piece of hose water can be siphoned from the basin until the bottle is full and the long siphon started working.

This represents quite closely a kitchen boiler, and by pressing the short piece of hose together so that no air can enter, you will have the same conditions as exist when all the faucets are closed on a house supply system. Then if atmospheric pressure could not act the siphon would not work; but contrary to science, the siphon will work and work freely. According to established laws atmospheric pressure is necessary on the surface of the water in the bottle. To

be sure that all the connections are tight, cover the cork with melted paraffine wax dripping from a candle and melt into every possible air hole by means of a torch. Fill the bottle again and start the long siphon. Then double the short rubber tube and press it together air tight. The siphon gradually diminishes in flow till it finally stops working. By admitting air through the short hose the siphon will start, and could be checked again by closing the hose, although as the bottle empties it takes a longer time to check the flow.

The next thing to do is to test the vapor theory of a siphon continuing to work after atmospheric pressure is destroyed, by filling the space, created by the water running off, with vapor or steam in sufficient quantity to force the siphon to act in the same way as the pressure of the atmosphere. Fill the bottle again and place in a galvanized iron pail full of water on a plumbers' gasoline furnace until the water is heated to about 140 or 150 degrees. Place the bottle as shown in the sketch and the siphon starts, after which shut the short hose air tight. With the hot water the siphon will work longer, and as the bottle empties still longer, showing that the vapor supplies the place of the atmosphere to a certain extent, though finally the siphon will stop.

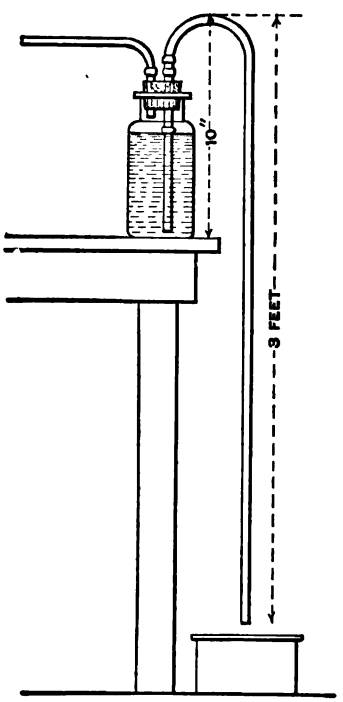


FIGURE 91.

This experiment will bring to light another effect. By keeping the short hose air tight after the hot water stops running, the vapor in the bottle will condense and destroy the equilibrium so that the atmospheric pressure on the outside is sufficient to drive the water in the long leg of the siphon up and back into the bottle, and to force air through the water in bubbles in sufficient quantity to restore the equilibrium.

From these experiments it is concluded that siphonage might continue to an extent sufficient to collapse the old form of copper

boilers that were not reinforced, but that in iron boilers the siphonage would never be likely to continue long enough to empty the boiler. Air will enter through openings so small that water even under pressure will not leak. Those who have had trouble with boilers siphoning know that simply loosening the coupling at the hot water supply connection will let in enough air to break the siphonage when there is no hole in the delivery tube near the top.

RELIEVING SIPHON OF AIR.

Q. I HAVE a siphon drawing water from a well on a hillside and delivering it 1,000 feet from the source. The system works well when first primed, but the trouble lies in the necessity of repriming it about once a week. Can you give me a suggestion on the best method of keeping air out of the pipe?

A. The following article, prepared and printed by G. D. Hiscox a few years ago, describes different methods of starting the action of a siphon and relieving it of air that would by accumulation stop its operation:

The siphon is one of the oldest devices for transferring water or other liquids to a lower level over a barrier. It was used by the Egyptians, and is pictured on their tombs of a date 1500 years before the Christian era. It was a favorite toy of Hero of Alexandria. Its greater use is in the drainage of mines and quarries, and for conveying water from springs over elevations that do not admit of economical excavation. The inverted form, which is not a true siphon, although so named in engineering phrase, has reached giant proportions as a conveyer of water across great valleys in Europe and our Western States. The fact that all water in its natural condition contains air in mechanical combination, which is liberated by removing the atmospheric pressure, is the only and great drawback

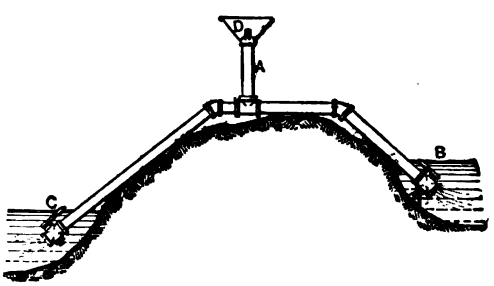


FIGURE 92.
A Simple Method.

to the continuous flow of water through it, up to a height near the atmospheric or vacuum limit of about 33 feet. The conditions of partial vacuum, or negative pressure, or, rather, loss of pressure, commence to liberate the air at a few feet elevation, and increase up to the limit at which the quantity of air breaks the continuity of the stream, when the operation stops, the rarefied air remaining at the apex, unless by some mechanical means it can be withdrawn from the siphon. When siphons have but small lift, say from 8 to 10 feet, and can be so arranged as to discharge enough lower than the water at the inlet end as to create a strong current, a siphon may run continuously by carrying the liberated air along with the water, but with heights of from 15 to 25 feet the air accumulates in quantity sufficient to cut the stream at the apex of the siphon and stop the flow; often in a few hours, when the apex is short and holds but little air.

We illustrate the essential features of a good siphon in Figure 92, which is simple, cheap, and easily managed, but requiring frequent removal of the air by closing the cocks at B and C and refilling the chamber at A and the apex of the siphon with water through the plug D, in the funnel. The chamber at A may be made quite large, to hold the air of a whole day's run. The top of the pipe A should have a reducing socket with a funnel of galvanized sheet iron soldered to it, as shown in the cut, to form a water seal over the plug, for the convenience of filling, as well as to insure an air tight joint at the plug, which, by frequent use, may not be perfectly tight, and here we should say that absolute tightness against leakage in of air is a most essential feature of the successful working of siphons.

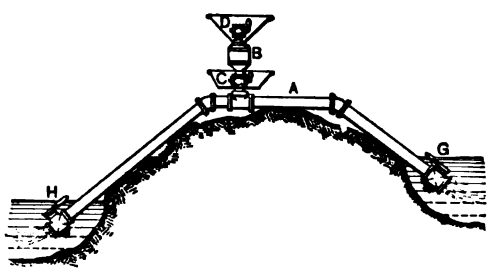


FIGURE 93.

A Method of Relieving while Operating.

We also illustrate, in Figure 93, an arrangement for replacing the accumulating air in a siphon with water without stopping the flow. In this plan make the apex section at A of a size larger pipe than the other parts of the siphon. This allows the liberated air from the rising leg to separate and float along the upper side of the pipe

and exchange with the water from the reservoir B. The slower motion of the water along the apex, and the placing of the tee piece very near the point of descent, allows of the separation of the air and prevents its accumulation beyond the outlet at C, and thereby choking the circulation. The two cocks C and D should have water seals as shown, to insure against leakage of air into the siphon. The reservoir B and the seals may be made of galvanized sheet iron with soldered joints, and attached by soldering to galvanized pipe couplings. To start the siphon, close the cocks H and G, open the cocks C and D, and fill the siphon and reservoir with water to the top of the funnel D, and also fill funnel C as a seal. Close the cock D and open the cocks G and H, when the water will flow with a velocity due to the difference of water level at the ends, less the friction of pipe and fittings. When the chamber at B has filled with air, which may be known by rapping on it with the knuckles, close cock C, open D, and fill with water, closing D first, and open C. After a few trials a constant siphon will become a time keeper, so that the filling of the chamber may be made at stated intervals. In regard to the sizes, for a 2-inch siphon the cocks C and D may be ¾ inch and the chamber from 1 to 2 cubic feet, according to height of siphon.

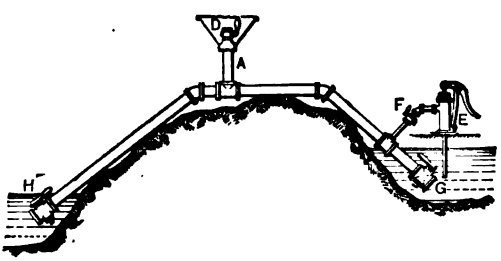


FIGURE 94.

A Method of Relieving and a Pump for Starting.

A siphon arranged as illustrated in Figure 94 is a most convenient one, where the apex is at considerable distance from the water supply; and for quarries, where the water drainage is limited and taken from sumps, which are exhausted by a short run of the siphon. This is essentially like Figure 92, with the addition of a common plumbers' force pump at E, connected to the siphon behind the inlet cock G, with a cock in its force pipe F; or if the stuffing box of the pump is air tight no cock will be needed at F. A small air cock in the funnel at D completes the arrangement ready for operating. By closing cocks G and H and opening the air cock in the funnel at A the whole siphon may be easily filled by the pump at E, also filling the funnel full. The air cock at D should be closed first, to

keep it sealed by the water in the funnel. The cocks G and H are then to be opened and the cock F closed. The siphon will then flow until the chamber A and part of the horizontal apex pipe become filled with air, when the operation of filling may be repeated. There is no special limit to the capacity of the air chamber, which may be made of a larger pipe than the siphon, and extended at a small angle sidewise, to give capacity for holding air without increasing the total elevation of the water head in the siphon. The air cock at D should never exceed an elevation of 32 feet above the cock at G. There is another way of starting and keeping up the flow of a siphon—by an air pump attached directly to the apex, with a cock in the position of the air cock at D, Figure 94. The operation of this plan can be made with a plain siphon, without cocks at H and G, and the pump used only to pump out the air when required, the starting of the siphon requiring no manipulation of terminal cocks, nor traversing over the distance of a long siphon. The only specialty is a good air pump. We do not recommend the use of cast iron pipe for siphons, the difficulty of keeping it absolutely air tight becoming an expensive item in its maintenance. Wrought iron black or galvanized pipe, with cast iron screw fittings, tarred or galvanized, make the only reliable outfit for siphonage. There is probably no limit to the size of a siphon pipe, within ordinary engineering requirements, with adequate facilities for removing the air.

A LONG SIPHON.

Q. WILL you please advise me in regard to bringing water from a spring 1,500 feet from point of delivery? The water has to be carried over a knoll 30 feet higher than the spring, the point of delivery being only 6 feet lower than the spring. What I want to know is, will the water siphon over the knoll with that amount of fall, and, if so, what size of pipe would be best for the purpose where only a small amount of water is needed?

A. Theoretically a vacuum is said to lift water 34 feet, and a 30-foot rise in a siphon would run but a very short time, as the amount of vacuum due to 30 feet would liberate the air in the water, and accumulate it at the apex to such an extent as to stop the flow. If trenches over the top of the knolls are possible, as in Figure 95, so as to let the pipe down to a 20-foot level from the spring with only one

apex, then an air trap, Figure 96, at the apex will give the siphon a much longer run and will be the point for filling and starting the water flow. If by a longer line the siphon can be carried around the knolls and so lessen the lift to a few feet only, it will be a great advantage in the care of the air trap. For the distance of 1,500 feet we

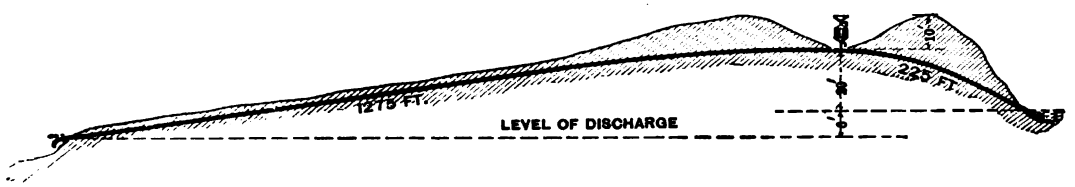


FIGURE 95.

Run of the Pipe.

cannot advise less than 1-inch galvanized iron pipe for family supply, which would flow with a 6-foot fall at about 3 gallons per minute. The discharge end of the siphon should be trapped against a back flow of air, and each end should have a stop cock to facilitate filling. Great care should be taken in laying long siphons that no inverts are made in the lines either way from the apex, as the high points of the inverts hold the air and impede the flow. Figure 96 shows a good form of air trap for the apex of a siphon, which allows of discharging the air by charging the trap with water. For a 1-inch siphon the trap may be made with two ½-inch cocks and nipples with a tee, 1 x ½ inch, on the main pipe. If the cocks have outside threads so much the better, as the less joints the less liability to leakage. The body of the trap may be made of galvanized sheet iron of a capacity of 4 or 5 gallons. The trap and all its fittings must be made air tight, as any leakage of air into any part of the siphon shortens its running time. Every part of the siphon and the trap

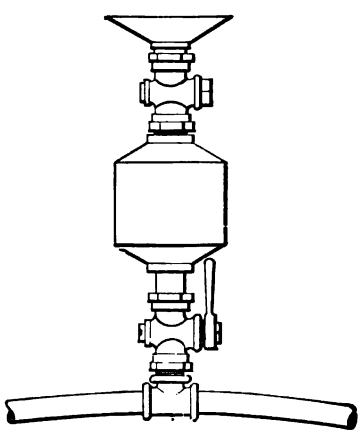


FIGURE 96.

Air Trap for Siphon.

should be protected against frost. To charge the trap, close the cocks at each end of the siphon and open both cocks in the trap; fill the siphon and trap through the funnel and leave the funnel full of water and a cover on. Shut the upper cock only. Open the cock in the spring first and then the one at the discharge end of the siphon, when the water will start flowing. The air that is liberated from the water in the rising leg of the siphon by the increasing vacuum will flow along and rise into the trap, displacing an equal quantity of water by difference of gravity. This operation will go on automatically until all the water is displaced by air, when the flow from the siphon will become less by its retardation from the accumulation of air in the main pipe. To recharge the trap, shut the lower cock and open upper one and fill as before. Close the upper cock before opening the lower one, otherwise the suction of the siphon will pull the water out of the trap.

WILL A SIPHON WORK?

Q. We have a well 100 feet deep in which the water rises to within 40 feet of the surface. Can water be drawn from the well with a siphon having a fall of 100 feet?

A. A siphon works through the water falling in the long leg and creating a tendency toward a vacuum in the short leg and the atmospheric pressure on the surface of the liquid in which the short leg is immersed forces the liquid up to fill the vacuum. As atmospheric pressure varies with the altitude above the sea level the height to which water may be lifted by it varies; but it will never raise water 40 feet. With perfectly tight pipes, water may be lifted about 30 feet by a siphon, but to keep the pipes or siphon air tight is one of the troubles experienced with all siphons. This trouble is reduced as the lift is reduced. If the water in the well can be depended upon to always reach a level of 45 feet below the ground a siphon can be used, if the pipe forming it is buried so that the highest point is 20 feet below the ground. This would leave a lift of but 20 feet when the water reached the 40-foot level and 25 feet when at the 45-foot level.

To operate effectively the pipe must be air tight and have a carefully preserved pitch both ways from the highest point. At this point a pipe should be carried up to the surface of the ground, hav-

ing a stop cock on it and terminating in a funnel. As all water has more or less air in it the air will accumulate at the high point in the siphon and in time stop its operation. Then it is only necessary to keep pouring water into the funnel with the stop cock open to start the siphon, when the stop cock can again be closed until needed. Lead pipe with carefully made joints is best adapted for a siphon, as there is less liability of air entering through it. The flow of water is governed by the head or distance of the delivery point below the point of supply and also by the friction due to the length of the pipe and its size.

THE THEORY OF THE ACTION OF FIELD'S SIPHON.

Q. WILL you explain the theory of Rogers Field's siphon? The obscure point is the pneumatic action involved, by which the sealing of the long leg of the siphon enables a very small stream to charge it, while, were it not so sealed, the liquid would merely dribble down the long leg, and the air would not be expelled. The books give no adequate explanation.

A. The dipping of the lower leg or outlet of the siphon in water facilities the expulsion of the air in this way: the water, as it falls through the tube, carries with it by friction particles of air, just as a stream poured from a pitcher into a basin will carry bubbles down under the surface of the water into which it falls. The sealing of the end of the tube prevents any of the air from getting back after once being carried out, so that a continuation of the process for a few minutes generally takes out air enough to set the siphon in action. Any contrivance by which the water may be made to fall into the basin at the foot of the outlet-limb freely—*i. e.*, without dribbling down the sides of the tube—will hasten the expulsion of the air by mixing air and water together on the way down. For this reason pure water works better than sewage, for the impurities of the latter soon collect upon any points or edges from which the water may be made to pour clear of the side of the tube, and by forming a lip leads the water back to the side of the tube again. For this reason it is difficult to make the annular siphons work on a small scale with sewage. The free admission of the air to the siphon after the tank is emptied is essential to the success of the device. If not so admitted—*i. e.*, if both ends remain sealed, with the siphon full of water—the tank will

not fill again, but the water will pass out through the siphon in driblets, as it comes in. In order to secure the emptying of the siphon, Mr. Field provides either a small siphon to discharge the lower basin after the tank is emptied, or a V-shaped notch in the edge of this basin to allow the water-seal to be broken by draining the water below the end of the outlet-limb. The seal is restored again as soon as the flow becomes enough to fill the notch. In this point, as we understand it, consists Mr. Field's invention, on which the patent for his curved pipe-siphon depends. The choking of this notch or lower siphon by the impurities of sewage forms the chief impediment to the general use of the invention, for it often ceases its automatic action when used for sewage, unless occasionally looked after to clear the rubbish from this point.

SIPHONING WATER THROUGH A BATH-SUPPLY.

Q. THE writer, while repairing the connections to one of the many styles of bath-tubs which admit the water at or near the bottom, noticed that when the tub is filled, and the water shut off at the stop and waste in the cellar, upon opening the cocks in the tub the water siphoned back through the stop and waste. This is, in his opinion, a fault with tubs of that kind, or rather in connections of that kind, and one which, in the judgment of the writer, might be easily remedied. Let the manufacturers see to this, and further improve a good thing.

A. It is not clear how manufacturers can guard against such a contingency. As a practical question, we imagine such an occurrence as that cited must be uncommonly rare, though we recently heard of a case where a small service-pipe conveyed water under a light pressure to a bath, and below it to a pantry-cock and sink. On one occasion, when the bath-cock was open and a person was bathing, the pantry-cock below was also opened and speedily began to discharge dirty water, because there was not sufficient pressure to deliver at both points, the water being drawn from the bath and discharged below.

If baths are to be supplied in this way, the inlet should be above the usual water-line, though in such cases the special object of the end-supply is lost, since it is used to avoid the steam from the hot water running in. If the bath-supply were taken from a tank, there

would be no risk of such an occurrence, but if, as in the case cited, the bath-cock is supplied from the same pipe that supplies several cocks below it, the opening of one or more of these lower cocks would draw the water back from the bath, providing its cock were open. We should, therefore, when the bottom supply is used, either rely on tank-supply, or be sure, if it is from street-pressure, to have the supply-pipe of sufficient size to permit water to flow at the bath, even if all the taps below it were open. In any case, it is another instance where the judgment of the plumber must be exercised.

Mr. Stephen H. Terry, of London, relates his experience as follows with regard to the foregoing:

"I will state my own experience, which goes to prove that water may be so sucked into the service-pipe, and delivered (mixed with water from the cistern) at taps below, the only requirements necessary to fulfill these conditions being that the tap or taps at the lowest level shall be open and capable of discharging (cognizance being taken of the difference in head) slightly more than the orifice of the service-pipe at its junction with the supply-tank.

"I have a cistern at the top of my house which holds about 500 gallons; this is on the third floor. On the second floor is a bath-room, closet and draw-taps. On the first floor is a lavatory and closet, on the ground-floor is a closet, and in the scullery a ¾-inch screw-down draw-off cock. About five weeks since, wishing to clean out my lead cistern, I commenced by running off the water, for this purpose opening the scullery and lavatory draw-off cocks, and fixing the pedal of the basement-closet open. Water was plentifully discharged from all of these. I then proceeded to open the draw-off taps in the bath-room on the second floor, about ten feet lower than the water-level in the tank (the tap from which the water was running being about thirty-six feet below the water-level). To my surprise, instead of water coming out, air was sucked in, with much gurgling sound. On going up to the tank overhead, I found there was still two feet deep of water in it, while air and water were being discharged below with considerable noise.

"I may mention that the service-pipe is a small one, one inch in diameter, and this is slightly—very slightly—throttled at the place where it is soldered into the bottom of the tank.

"From the above description it is evident that all that is necessary for the suction of bath-water, or other even more objectionable

liquid, into the service-pipe, is that the supply to bath or sink, or, for that matter, closet, should discharge below the level of the water in such bath, sink, or closet, and such conditions, unfortunately, are not difficult to fulfill. A bath may be left full of dirty water at a time

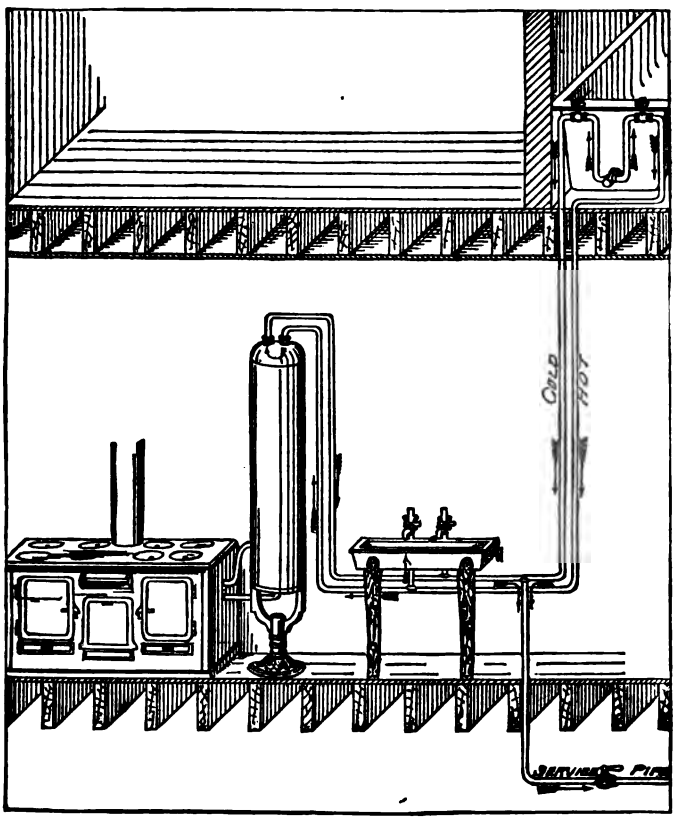


FIGURE 97.

when the cistern above is nearly empty, the supply-cock may be open, the taps in the basement may be opened, and in that case the whole of the bath-water might be siphoned out through the supply-cock, as soon as water comes on from the main to start the siphon. Sinks and closets may become choked with tea-leaves or thick paper, and other material which should not be thrown in.

"The lesson to be learned from this is that the regulations of the Metropolis Water Act, 1871, framed partly to prevent waste of water

and partly for purposes of promoting public health, should be attended to. I quote Regulation 26:

"'In every bath hereafter fitted or fixed the outlet shall be distinct from and unconnected with the inlet or inlets; and the inlet or inlets must be placed so that the orifice or orifices shall be above the highest water-level of the bath. The outlet of every such bath shall be provided with a perfectly water-tight plug-valve or cock.'"

We are glad to record this further instance of the risks incurred in a supply to a bath entering below the water-line, especially as our attention has been called to another case, in which, as in the one cited above and in those which we have before cited, the mishap seems to have been due to insufficient size of main supply-pipe to the various fixtures. The risks of direct supply to a valve on a water-closet without the intervention of a cistern are also above forcily illustrated.

EMPTYING A TRAP BY CAPILLARY ATTRACTION.

Q. I WAS requested a few days ago to investigate the cause of a terrible stench, similar to that found in a sewer, which filled the bath-room (which also contained a water-closet) almost to suffocation during the early hours only of each morning, and until the water-closet had been used or the bell-pull lifted. The cause for this terrible stench was found to be a most peculiar one indeed—viz., a large 4-inch P-trap being siphoned by capillary attraction.

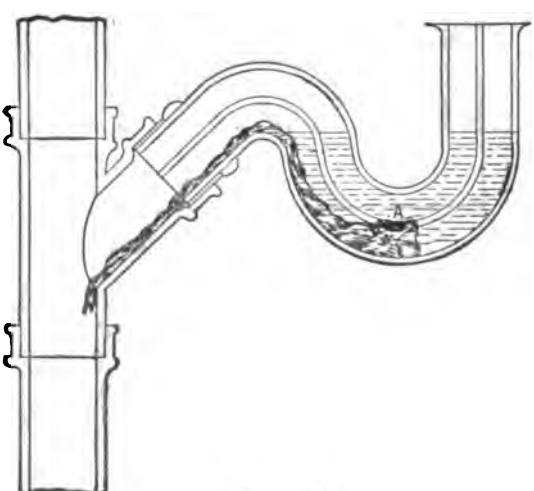


FIGURE 98.

The entire plumbing-work was carefully examined, but no leak or other defect was visible. Yet the trap under the water-closet was found to contain very little, if any, water for several consecutive mornings. Then

a series of the usual but most severe trials or attempts were made to siphon this trap (there is a similar bath-room above this one, and *all* using the same soil-pipe), all of which failed.

Then the water-closet, etc., was removed, and the following was found—viz.: The trap was found to be a hand-made, soldered, side-seam one, made of sheet-lead. In soldering the seam, some of the hot metal had been permitted to protrude beyond the *inner* side of the trap, and thus formed a projecting "peg," on which a large cloth had caught in attempting to pass. As the closet necessitated the use of a considerable quantity of water, the effect was to attempt to carry the cloth out of the trap, but the actual result was to firmly retain one portion of the cloth at the lowest point (nearly) of the trap, and carry, in a continuous line, the remaining portion up and out into the soil-pipe, thus completely siphoning the water from the trap during the night hours, when the water would not be replaced at short intervals. A similar circumstance was found in the trap of a kitchen-sink almost two years since. However, in this case the trap had first caught some shreds of cloth on the rough edges of the trap-screw, the result being almost identical with the above. I send you herewith a sketch of the first described trap, which you are at liberty to use in such manner as you deem proper.

A. The trap described above was an old-fashioned one, such as is not made nowadays. Yet the imperfection seems to have served a good purpose in this case in drawing attention to the cloth in the trap. If it had been washed through it would have been very likely to make a dam at some other point less accessible than this one, and render it necessary to cut the pipe open to get it out. If the water-closet had been a simple hopper with accessible trap there would have been no need to remove it, for any one could have reached the cloth in a moment.

Moral—Avoid complicated fixtures, and preserve all textile fabrics for paper stock instead of putting them down the drains.

A New York plumber had his attention directed to this same capillary action, and made several experiments upon it, which satisfied him that, under some circumstances, it could and did cause the loss of seal where other explanations failed to account for it, all of which enforces the moral cited above.

WATER SUPPLY AND SERVICE PIPES

IN ARRANGING for a water supply it is important to avoid the possibility of contamination from any cause and to provide for a sufficient quantity both at the source and in the piping bringing it to the place of use. In making these provisions conditions confront the inexperienced who overcome them with difficulty or at an unnecessary expenditure of effort without assistance such as may be gained by consultation or reading of the troubles met and remedies applied by others. The experiences described here cover a variety of conditions and their value has been proven in practice.

SIZE OF WATER-SUPPLY PIPE FOR DWELLING-HOUSE.

Q. How large water-pipes ought I to have in a house where there are six wash-basins, two water-closets and baths, with kitchen-sinks, laundry-tubs, etc.? Will the size of hot and cold water pipes be the same?

A. That depends somewhat on the pressure in your street-mains. Assuming it to be forty pounds per square inch, we should say one inch from street to near the boiler, three-quarters of an inch from that to each bath-tub, with ½-inch branches to each water-closet cistern, basin-cock, and ⅝-inch branches to sinks and wash-tubs. All these dimensions might be reduced one size if the money saved thereby was of more consideration than the extra time required for drawing the water through smaller pipes.

THE LIFT OF A PUMP.

Q. WE would like to know from what depth water can be drawn by a pump.

A. At the sea level the air pressure is about 14¾ pounds to the square inch, which is equivalent to a water column about 34 feet high. In other words, a pump piston creating a vacuum with no leakage will raise water about 34 feet. Our correspondent knows,

however, that the imperfections in pump construction render it only practicable to pump water a shorter distance than this, and 25 feet is about the limit of a successful and easy operating pump. On the other hand, as we ascend the air pressure becomes less and less, as a barometer will indicate. For instance, at a distance from the sea level of ½ mile the pressure is only 13.3 pounds per square inch, and a pump, therefore, would only raise water at that height 30.7 feet. At the height of a mile the pressure is further reduced to 12 pounds per square inch, which would permit suction pumping from a depth of but 27.6 feet.

PUMPING A LONG DISTANCE.

Q. PLEASE inform me what sized pipes you would use and how many valves, and where you would place them, to bring water easily from the spring, according to the arrangement shown in Figure 99.

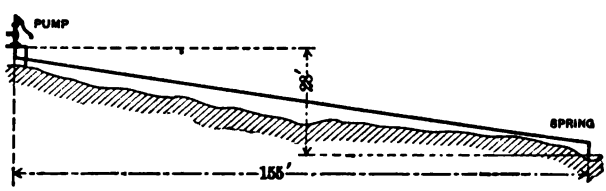


FIGURE 99.

The height of the pump is about 28 feet above the spring, and the length of the piping 155 feet, the pump being a No. 3 Douglass force pump.

A. The height of the pump, as stated, is very near the limit of reliability, and we advise the use of the style of pump with the valve chamber set 5 or 6 feet below the pump base. This can be readily done by sinking a pit and bringing the suction in at as great a distance below the pump as can be done. This will give, if 6 feet depth can be made, a lift of only 22 feet, which will give the pump a good working capacity for the long suction pipe. Use 1½-inch pipe for the suction, with a foot valve and strainer at the spring. Put a rising pipe in the pit, connected to the suction close to the pump cham-

ber, and extending up to a convenient place for charging the suction pipe with water to start with, and close the top air tight with a cap. This answers the double purpose of an air chamber and charging pipe.

Q. Figure 100 shows the location of the pump, the spring from which the water is pumped, and also the cistern from which the same pump draws water as now in operation. This is arranged as suggested, with the exception of the valve chamber, which, instead of being 6 feet below the pump as suggested, is located much nearer to the pump. Valves are placed on the main pipe from the spring and the pipe from the cistern, so that by shutting off a valve water can be drawn either from the cistern or from the spring as desired. I put in a 1¼-inch pipe as shown to use for charging the spring pipe line and also to serve as an air chamber, it being capped air tight at the top. The pump draws the water, but does not give satisfaction because it works hard and the handle flies up as the valve is shutting after the pumping stroke is completed. I would like to know what is the best way to fix this pump so that it can draw water from both the cistern and the spring without working so hard. The pump in use is a No. 3 Douglas force pump.

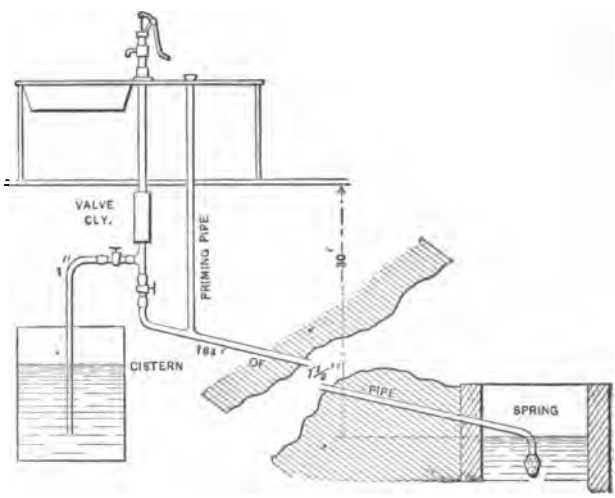


FIGURE 100.

A. It will be noticed from the sketch that the water must be lifted to a height which is very near the limit of usefulness in a pump and this naturally makes the pump work hard. The best way to ease the action of the pump is to lower the valve chamber. It is the cus-

tom of some men who have had experience in pumping a long distance to enlarge the pipe one size at a point half way between the pump and the source of supply, carrying the larger size of pipe from that point to the point of supply.

DEEP WELL PUMPING WITH AIR.

Q. I WOULD like to ask what is the best way to get water out of a well which has been drilled with a 5-inch auger to the depth of about 100 feet. The well is cased with galvanized iron pipe. Is there not some way of forcing the water up by air pressure, as the climate here is too cold for pumping?

A. As our correspondent has neglected to state how high the water stands in his well we cannot say what can be done with the air pressure system of pumping because its operation depends upon the depth of water, in proportion to the height above the water, that the water is to be raised. It is not economical by the air pressure system to raise water to a greater height from the surface of the water in the well than the depth of the water below the water line when pumping. If the well holding water at one-half its depth is a slow flowing well, so that by pumping the level falls fast, say to one-half its depth, the quantity of air required to lift the water to the increased height will be so great that it will cost more than by direct pumping. Under any circumstance this does not mean the obtaining of a little water by a small flow of air, as a full charge of air at full pressure is necessary for a discharge. It cannot be kept going like an ordinary pump with a small discharge. For the air system of deep well pumping, supposing that in our correspondent's case the well is 100 feet deep and the water rises 50 or more feet, there will be needed, according to the capacity of the well or our correspondent's wants, a 1½-inch pipe with a ½-inch pipe lashed to it and turned up under the bottom of the 1½-inch pipe with two elbows, let down into the bore of the casing to near the bottom; then an air pump equal to the quantity of air at the pressure due to the depth of the water in the well, and to the displacement of the water, required with an air reservoir to equalize the flow of air, will make up the principal outfit. For a smaller apparatus, a 1¼ or 1-inch pipe with a ⅜-inch air pipe may be used. For compressing the air a wind mill may be used with an air cylinder and a large tank for air storage, so that when water is

wanted the air may be let into the pipe with a valve, and when the supply of water is obtained the water in the pipe drops to the well level on closing the valve. Gasoline engines are also used for air

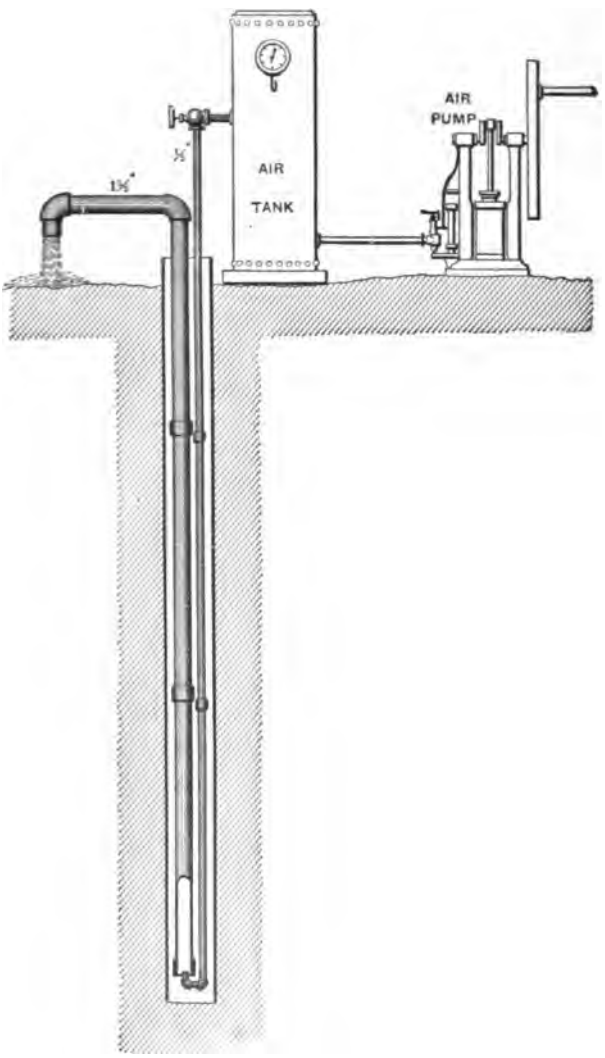


FIGURE 101.
Deep Well Air Pump.

compression. One person on a double acting air pump 3 x 6 inches could readily pump air enough for 10 gallons water supply from our correspondent's well in one minute.

HOW TO DRAW WATER FROM A DEEP WELL.

Q. CAN a pump be got that is workable by one man to draw water from a well 100 feet deep; and, if not, what is the greatest depth such a pump will draw, and where obtained?

A. The pump-bucket must not be more than 20 to 25 feet above the water, in order that the pump may draw. A pump can be made with the foot valve and bucket 80 feet below the surface, but it would take a pretty powerful man to work it, for at every stroke he would have to lift a column of water 80 feet high of the diameter of the pump bore.

INTERMEDIATE TANKS FOR THE WATER-SUPPLY OF HIGH BUILDINGS.

THE extraordinary height of many of our office buildings and apartment-houses is such that water forced to a tank at or near the roof and distributed downward has a pressure altogether too great for many of our ordinary plumbing fixtures and for lead pipe of usual thickness.

In the case of the Tribune Building in New York, the height water is pumped is about 170 feet, which to distribute backward again would bring on a fixture in the basement or cellar a pressure of from 70 to 75 pounds per square inch—in itself too much for fixtures, but that, when taken in connection with the "water-hammer," which will be likely to occur, would be almost sure to destroy the strongest made valves, etc.

To obviate this, in the above-mentioned building the architect provided an intermediate tank *t* and placed it midway between the floors on which water-closet and bowl fixtures are used. The cisterns for the water-closets on the fifth floor and all fixtures above them take water from the upper house-tanks (H T), while the wash-bowls on the same floor and all fixtures below them take their supply from the intermediate tank.

The diagram shows the arrangement of the tank-pipes and system generally. The pipe from the Croton main connects with the meter M, and the water is regulated into the lower tank (T) by a ball-cock;

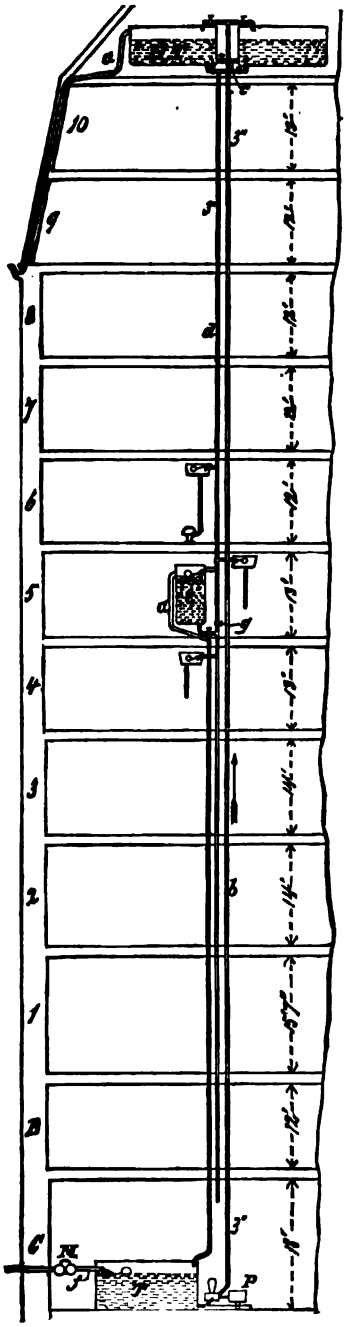


FIGURE 102.

this tank is below the sewer-level and has no overflow. From the receiving-tank the steam-pump (P) elevates the water to the upper house-tanks. These tanks overflow to the eaves-troughs and have no direct communication with the sewers. Tank *t* takes its supply from the upper tanks and is regulated by a ball-cock; it is also furnished with an overflow-pipe *a*, whose lower end is carried to the receiving-tank. This is to prevent loss of water should the ball-cock fail. It also acts as a tell-tale. Two house-tanks are used, with a system of change-off valves and an equalizing-pipe. All the tanks are of wrought-iron.

PUMPING AIR FROM WATER-CLOSET INTO TEA-KETTLE AS RESULT OF DIRECT SUPPLY TO WATER-CLOSETS.

Q. I NOW live in a house in which the plumbing was passed by the Board of Health Inspector. On the second floor is a valve pan-closet. This valve is supplied direct from the rising main to the pump that is intended to pump water into the tanks and over sinks on each floor above. I have seen the pump upstairs discharge water over the sink when the water-closet below was in use, that smelled like the contents of the water-closet. Of course, the closet happened to be in use at the moment, and the valve being open the suction from the pump above drew the foul air from the closet-bowl so that the water was impregnated with it. I thought it was against the law to connect any more closets to drinking-water mains. How is this?

A. It is probable that the work in this house was begun before the plumbing law of 1881 went into operation. We have taken the trouble, however, to have a sketch prepared, so that all our readers can fully realize the character of the risks incurred when valves on water-closets are supplied by branches from the main water-supply from which water for drinking and cooking is drawn. Figure 103 fully illustrates the nasty practice, and its very probable consequences, yet water-closets are fitted up in this way in great numbers of houses in this city, and aside from the wastefulness of water attendant on this method, the risks to health which have been demonstrated over and over again are such as should compel our health authorities to institute a systematic inspection of all the houses in this city, and they should, as rapidly as possible, require the discon-

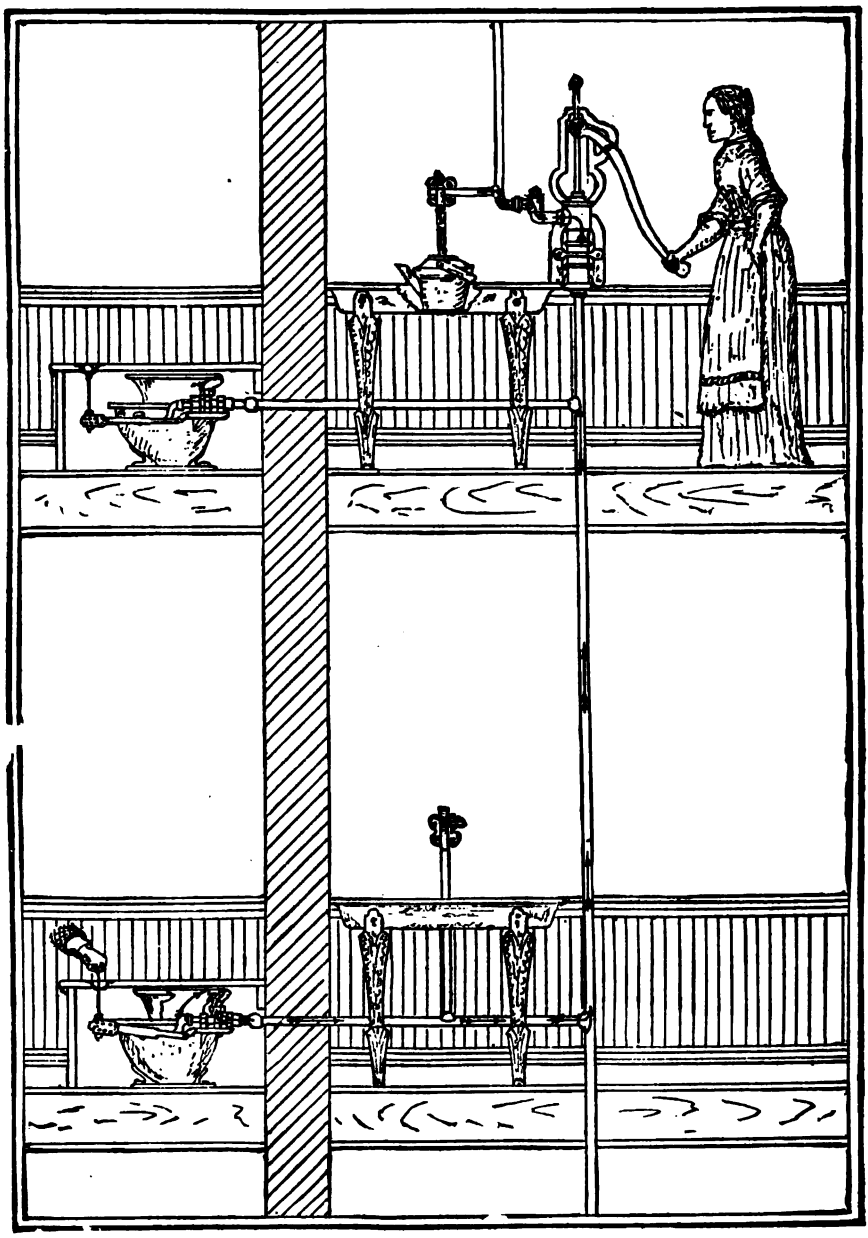


FIGURE 103.

nection of all direct supply to water-closets, and the abandonment of the filthy practice that ignorance and cupidity have made so prevalent.

HOT AND COLD WATER SUPPLY.

BY D. F. N.

A GREAT deal of trouble has been experienced with the water supply system in a large apartment house in the upper part of New York City. The building is eight stories in height. The water service system was arranged to be supplied from both the street main and a 1,500-gallon tank on the roof. From this tank a 1¼-inch falling main dropped to the eighth floor ceiling, at which point it was connected with the distributing lines running across the floor beams and arranged in the shape of the letter H, as shown in Figure 104, 1-inch falling mains dropping from each branch to supply the kitchens and bathrooms, which were immediately above one another. All these 1-inch falling mains were provided with valves between the fourth and fifth floors, as shown in Figure 105, which is an elevation showing the piping system. The fixtures on the floors above these valves were supplied with water from the tank, while the fixtures on the lower floors were supplied from the street mains. A 1-inch distributing main heater from the street supply was arranged on the basement ceiling in the same manner as that used on the eighth floor, as shown in Figure 104, and was connected with the falling mains on the fifth floor, where the valves were located. A 1-inch branch from the street main supply was carried to the hot water storage tank, and a 1-inch branch from the tank supply was connected with the street supply to the hot water storage tank. In order to secure

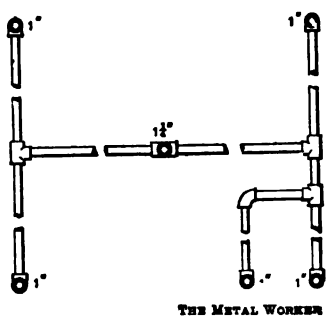


FIGURE 104.
Water Supply Header.

trouble was still further increased by the location of the check valve, No. 9 in Figure 106, on the cold water supply to the hot water service tank, which prevented the water from the street main entering this tank.

In order to prove the correctness of his opinion the stop cock on the street supply to the storage tank was shut down over night. The next morning the tank on the roof had an abundance of water, and there was plenty of hot water on the eighth floor. On examination of the check valve it was found that it had been strained and would not fall into its seat without slight force, so it had allowed water to leak from the house tank back into the street supply system. The old check valve was removed and a new 1-inch horizontal swing check valve was put in its place. As soon as this bad feature of the system was removed no further trouble was experienced. A ½-inch leader was taken from the pump pipe above the check valve, No. 7, Figure 105, so that the pipe could be emptied after the tank was filled, thus preventing freezing at the upper end. On the suction line to the house pump one 24 x 10-inch suction chamber was placed, to give the pump a body of water to draw from and to prevent the pump from drawing air into the system through the ball-cock on the flush tank in the engineer's water-closet. Another alteration was to put in a new telltale pipe from the roof tank to the sink in the basement.

The dusky engineer had a rather original way of telling when the tank was full. His telltale was to pump into the tank until it overflowed on the roof; then when he could see the water running down the leader trap in the basement, from which he removed the cover, he was sure that the tank was full. This gives some idea of the expense borne by those who employ the cheapest plumber, who gets a profit, if possible, whether the owner gets a profitable apparatus or not. A little increase in the first cost would have secured a properly arranged piping system with all the necessary valves, etc., for its proper use and a valve board giving explanation of their use. Men who work too cheaply do not include these conveniences in their job. In many instances, as in this, coal is bought regularly to overcome defects that good business judgment would have avoided by employing a competent contractor at a price that would insure an economical and effective system.

WHERE TO PLACE A TANK TO GET GOOD DISCHARGE AT FAUCET.

Q. How little difference in elevation can exist between the top of cold-water tank and hot-water faucet and maintain a good delivery at said faucet, the two being in the same room and connected through a hot-water boiler in story below?

A. This depends altogether on what is meant by a "good delivery." The discharge depends entirely on the difference of level between the cold water in the tank and the faucet. If your pipe is twenty feet long, and you want to draw two gallons a minute, your faucet must be about twenty-seven inches lower than the water, but if you want four gallons a minute it must be about seven feet lower.

IS GALVANIZED PIPE DANGEROUS FOR SOFT SPRING-WATER?

Q. CAN you give me any opinion as to danger of water-poisoning from the use of galvanized pipes for soft spring-water?

A. This question was referred to Prof. William Ripley Nichols, who has prepared the following:

"It would be difficult to give an opinion of any value without more knowledge of the character of the water than is conveyed by the term 'soft.' If the water is what we should consider soft in this region, if a fair proportion of the dissolved salts consist of carbonates, and if there is no excess of carbonic-acid, the so-called galvanized pipe can, no doubt, be used with perfect safety; if the water is effervescent, or contains an excess of carbonic-acid without actually effervescing, especially if chlorides are present (or sulphates other than sulphate of lime), it would perhaps be better not to use the pipes. Even in the latter case, however, if in the morning or whenever the water has remained for any considerable length of time in the pipes, enough water is wasted to thoroughly flush the pipes before any is used for drinking or cooking, there will probably be no danger. In this case a filter of bone-coal would be an additional safeguard.

"As to the general question of the action of water on zinc, the matter was quite fully studied a few years after the manufacture of articles of the so-called 'galvanized' iron began, and the experi-

ments of Mallet (British Association Reports, 1838 and 1840) are justly considered classic. All ordinary waters act more or less on galvanized-iron with the formation, as a rule, of oxide of zinc, which is subsequently changed to a hydrated carbonate. This coating may be to a certain extent protective, and, when once formed, it may check the corrosion of the underlying metal. It is not, however, very coherent, and where there is a flow of continually renewed water, as in the interior of a pipe, the coating is continually removed and reformed. Water drawn from such pipes, especially after standing for some hours, usually contains more or less oxide or carbonate of zinc in suspension, and, at the same time, some zinc in solution. It is stated—and it is the experience of the writer—that the corrosion from the first takes place irregularly in patches; at any rate, after a longer or shorter time, depending upon the quality of the pipe and the character of the water, the iron becomes exposed in spots; then the corrosion proceeds more rapidly, and after a time—in fact, from that time—the pipe has no superiority over a plain iron pipe.

"As to the danger to health: Although certain compounds of zinc are known to be poisonous if taken in sufficient quantity, it is generally held by those who have given particular attention to the subject, that ordinary water may be conveyed with perfect safety through zinced pipes. Some chemists have reported finding so much sulphate and so much chloride of zinc in a given water, but, as any one acquainted with chemistry knows, these compounds cannot be *identified* as such when they occur in small quantity, and the cases are exceptional where it is not erroneous to *regard* the zinc as thus existing. In most waters it is justifiable to regard the dissolved zinc as existing as carbonate, and the amount, at the most, is so small that the action on the system is not to be feared, at least from an allopathic point of view. It is said that 'there are on record a number of cases of zinc-poisoning from the use of galvanized-iron pipes.' This may be so, but in some of the cases, at any rate, the records are decidedly open to criticism. The question of the use of galvanized pipes, tanks, etc., was investigated quite thoroughly in 1873 for the Massachusetts State Board of Health by Dr. W. E. Boardman, who gives the *pros* and *cons* in the matter. No doubt the investigation was undertaken partly because of the then somewhat recent occurrence in the neighborhood of Boston of cases of sickness and death which were *ascribed* to the drinking

of water which had passed through 'galvanized' pipe. Dr. Boardman and other competent physicians concluded that there was not in 'these cases adequate evidence to establish the correctness of the opinion given as to the nature of the illness in the way of cause and effect,' and other cases were investigated with a similar result.

"The writer would not wish to be understood as implying that there may not be cases of well-authenticated ill effects; he is familiar with waters in connection with which he certainly would not advise the use of zinced pipe, but these waters would not be recommended for domestic use. The largest amount of zinc *in solution* which the writer remembers at the moment to have met with was 0.85 grains to the gallon; this would correspond to nearly 1.1 grain of oxide of zinc. A much larger amount could exist in solution, even in the form of the difficultly soluble carbonate. As much as six grains has been reported in *solution and suspension* together, but in such cases probable the larger part was in suspension. For the particulars of the effects of the different compounds of zinc, the size of doses given medicinally or for experimental purposes, and for other similar data any persons interested are referred to the paper of Dr. Boardman alluded to above."

MATERIAL FOR WATER SERVICE-PIPES.

Q. I SEND with this the engineer's report upon our water-works, not yet completed. All things considered, is there anything better than the lead pipes for tapping the mains? I understand that these only are allowed by the Water Board. Is experience against iron pipes?

A. Whether lead or iron service-pipes are better depends upon the chemical constituents of the water which is supplied. Wrought-iron pipes are liable to become corroded, particularly with soft waters. They are used for service-pipe in a great many towns, however, but lead-pipe is generally to be preferred for this purpose as less liable to leak from settlement.

TAR COATING FOR IRON PIPE.

Q. I HAVE about 400 feet of old 4-inch cast-iron water mains, which I would like to coat inside and outside with tar by dipping. Can you give me any advice as to how to prepare the tar? Is there

anything to be put in it to make it dry and must the pipe be heated before dipping?

A. For coating cast iron pipe with coal tar or asphalt an iron trough a little longer than the pipe to be coated and about 2 feet deep, with width enough in which to handle a single length of pipe, will be needed. It should be set so that it can be heated to the boiling point of the tar or asphalt. The pipe should be heated a little above the temperature of the hot tar and dipped so that the small end reaches the bottom of the tank before the hub is immersed, so that the tar rises on the inside freely and the air is carried off quickly. One minute's immersion is sufficient, when the small end should be raised first at a sufficient angle to drain the inside quickly. Lift the pipe out and place upon a frame to drain and dry. Another way to tar a small quantity of pipe is to heat both pipe and tar and raise the bell end so that a little hot tar can be poured in and a swab run through, turning the pipe over to insure a thorough coating. This can be done while the pipe is over the fire, when it can be rolled to one side and the outside swabbed with the tar.

WHY A HYDRAULIC-RAM DOES NOT WORK.

Q. WILL you please give me reasons why a hydraulic-ram stops working? The spring is 106 feet from where the ram is set; the feed-pipe from spring to ram enters the spring about two feet below the top of the water in the spring. It has on it a perforated copper strainer. The feed-pipe from spring to ram is 1½-inch galvanized-iron pipe. The ram is one of Rumsey's No. 3. There is a fall of eight feet from strainer to ram, and ten feet from top of water in spring to ram. From ram to house is 450 feet of ½-inch galvanized pipe, and the ½-inch pipe runs over a hill. It will work at times for three or four days, and then again will stop, sometimes in half a day. I think it air-bound where it goes over the hill. Am I right or wrong, and how can I remedy it? The end of ½-inch pipe is open all the time.

A. It is very probable that the pipe does get "air-bound" at the summit. A small air-chamber at the summit, made by a branch with a vertical pipe on it at the summit, would relieve the pipe. There should be a cock on the upper end of the branch, to be opened occa-

sionally while the ram is working. The force-pipe is too small to expect good service from the ram. The friction in 450 feet of ½-inch pipe is very great.

TROUBLE WITH A HYDRAULIC RAM.

Q. PLEASE advise me in the following case: There is a hydraulic ram which works intermittently now, although in use for several years. That is, the supply of water, fall and delivery have been tested. The ram has a new air chamber and flow valve. The feed and discharge and service pipes are apparently clear from obstacles, and the outside valve when raised by the flow often remains up, but if pressed down to its seat will work for varying lengths of time. The ram has been tried since getting new pieces as above in all ways —that is, with a full head or minimum; all the joints made tight and the valves put in order, or so reported, and being new from the factory they probably are in good order. A late discovery is that the drive pipe is leaky near the ram and possibly in other places. There seems to be no lack of water from it. Under these circumstances should the failure to work follow from a leak in the drive pipe or from a fault in the ram?

A. A leak in the drive pipe will, undoubtedly, diminish the effects of the ram, since the action of this apparatus depends upon the momentum of the water when suddenly checked, and if the water can find an escape through a leak in the drive pipe it will not compress the air in the chamber as much as it would otherwise, and it is the compression of air in the air chamber that acts as a spring to push the water up. Some years ago I had just such trouble with a ram that had been in use about thirty years. The brass outside, or pulsating valve, was very much worn and would keep stopping. I reasoned, that the valve being lighter than it originally was, was not heavy enough to fall when it was relieved by the air chamber valve. So with that idea I fastened a reducing coupling on the end of the brass stem and inside the coupling put a piece of solder, as shown in Figure 107. When I left

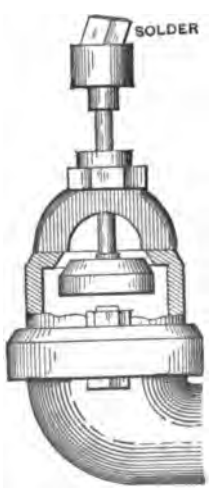


FIGURE 107.

it appeared to be working all right, and from inquiries I found that it continued to operate satisfactorily. Another remedy is to put a spring on top of the valve so that when the valve is knocked up by the water in the drive pipe, as shown in Figure 108, it just barely touches the spring, which always pushes the valve down. By placing the finger on the spring when the valve is in motion it should just be felt to touch. The air hole must be near the ram so it will supply the air chamber, otherwise the ram will work with a ruinous concussion. Perhaps the ram may be too large for the supply of water on hand.

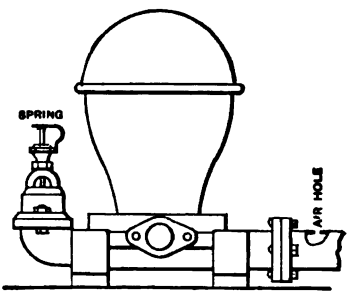


FIGURE 108.

PROTECT TANK PIPE FROM FREEZING.

Q. WE have a customer who has a water tank supported on a steel tower some 80 feet above the ground. This tank is supplied by means of a 2-inch iron pipe, and we would like to know the best method to follow to prevent this pipe from freezing in severe weather when it is filled with water.

A. There are four principles which are very frequently neglected or omitted, and lack of knowledge, which is the cause of all the trouble of the tank pipe freezing. The neglect consists in not having the pipe absolutely water tight before applying the covering; in not using proper non-conducting material, in a poor or careless application of it and in not changing the temperature of the water in the tank at least once a day. The best possible form of non-conducting material applied to exposed water pipes creates no warmth, acting simply as a non-conductor to frost from the outside surface of the pipes. During freezing weather the temperature of the water in the tank should be changed at least once every 24 hours by pumping a few hundred gallons of water into it, which, if taken from a spring or well, will be at a temperature of about 50 or 52 degrees. If this is not done during freezing weather the water in the tank will reach freezing point, and in consequence the water in the pipe will freeze from the inside, and all the protection that might be applied will not

prevent it. The pipe should be absolutely water tight, also where it enters the tank, there should be no possibility of leakage occurring, and by applying a proper non-conducting material the pipes will be absolutely protected from freezing under any temperature. One of the best coverings is sectional cork pipe 2¼ inches thick, carefully applied, so that all joints are absolutely tight, and then wrapped with canvas, painted with two coats of water proof paint, carrying this covering flush against the tank bottom and extending it to at least 4 feet below the ground. Then, during freezing weather, change the temperature of the water every day by pumping more water into the tank.

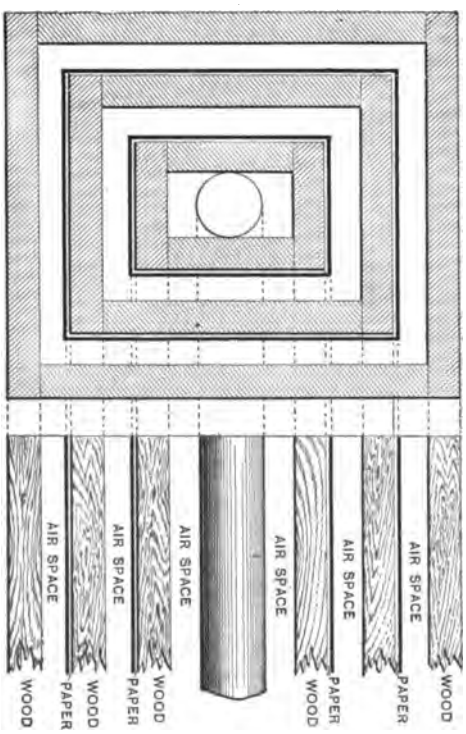


FIGURE 109.

Another correspondent writes: "My experience has been that I have been unable to find any non-conducting material that would protect a supply pipe to a tank from freezing, and I have tried all the best loose and sectional non-conducting materials that have been recommended and placed on the market. I have always found, after the covering has been on for one year, that it would help freezing in the pipe, owing to dampness brought on by the atmosphere. I have experimented with the different methods of wrapping, covering, boxing, etc., and the method that I suggest will absolutely prevent the water in the pipe from freezing if the temperature be 20 degrees below zero. Place around the supply pipe what may be termed a three-ply box, a cross section and an elevation of which are shown in Figure 109. This box must be attached to the bottom of

the tank with an air tight connection and must extend at least 3 feet into the pit below the ground. Each section of the box should be made of ⅞-inch finished pine boards or something equal. The first box, in order to cover a 2-inch pipe, should be 4 inches wide to allow for laps, and 2¼ inches deep from front to back. This leaves an air space all around the pipe. When this has been connected to the bottom of the tank, so as to be air tight, it should be wrapped with sheathing or manila paper from top to bottom carefully, so as to be as nearly air tight as possible. When this has been completed 1 inch square cleats should be nailed on the box about 5 feet apart, to which the outer boxing or next ply of the box is to be fastened, equalizing the air space all round. When this has been completed, taking the same care to make an air tight connection at the bottom of the tank, it should be wrapped with the paper the same as the first ply. On the outside nail more cleats of the same size to provide an air space, and put on a third box, to be made of 12-inch wide finished boards, which can be painted to preserve them. The second ply can be made of 8-inch boards. Having met with the best success in using this method for the last eight years I can say from experience that it is better than anything else I have tried. I have experimented with it and given it the severest kind of test and I have never had a frozen pipe which has been protected in this manner."

COVERING FOR WATER-PIPES.

Q. A CUSTOMER of mine would like your opinion as to what covering is the best for lead water-pipes, to prevent freezing. I suggested various things now in use, but he desires me to inquire of you as an authority, knowing you generally exhaust a subject when your views are solicited.

A. In answer to this question we would say that a plumber whom we consulted says that mineral-wool was altogether the best thing he knew of. Before that came into use he used asbestos, but of late he has used mineral-wool exclusively. Another had never used mineral-wool, and could say nothing about its efficacy or comparative cost. He generally used felting (which comes in sheets), but he always turned that over to his "felter"—never did it himself.

Where the pipes were to be exposed to the weather, as above roofs, he had the canvas covering painted.

He also frequently used plaster of Paris, inclosed in a wooden box surrounding the pipe. This was cheaper and quite as effective, if properly done, though not so elegant. He also has used sawdust in boxes surrounding the pipe for the cheapest work. Not knowing the particular circumstances of the case, he could not say which he should use. And a well-known sanitary engineer, to whom the matter was referred, also adds: "The above is all sensible, and covers the subject."

CONDENSATION ON SERVICE PIPE.

Q. WHAT will stop the condensation on a 3-inch galvanized iron pipe running into a cellar and also on the service pipe of 1-inch lead which is taken off from it? There is about 250 feet of this pipe and the condensation is so great that it keeps the cellar floor underneath the pipe wet all the while. Is there any way of stopping it?

A. The wet floor is caused by the moisture in the air condensing on coming in contact with the cold surface of the iron and lead pipes and dropping off on the floor. To stop the condensation and the drip it will be necessary to prevent the moist air coming in contact with the cold surfaces. This can be done by simply covering the exposed piping with asbestos paper, hair felt or any similar good insulating material which will prevent the air from coming into contact with the cold surface.

SIZE OF WATER-PIPES IN A HOUSE.

Q. PLEASE inform me the size of lead pipes used for cold and for hot supply in an ordinary house with water on three stories. Also, what should be the size of the circulation-pipe as compared with the hot-water pipe?

A. The size is somewhat controlled by the ordinary street-pressure. A 1-inch main-supply from street-tap to rear of house, with ¾-inch branch to boiler and as far as the baths, ⅝-inch beyond that, and ½-inch branches to basin-cocks and water-closet cisterns, will

give a good flow at all times. If pressure is very strong and cost is an important consideration, these may be reduced one size. The return hot-water circulation-pipe should be at least ¾-inch.

AUTOMATIC SHUT-OFF FOR GAS PUMPING-ENGINES WHEN TANK IS FULL.

THE following inquiry has suggested a description of an automatic arrangement for turning off the gas-supply to a hot-air pumping-engine:

Q. Can you let us know whether there is any device whereby the gas-supply to the caloric pumping-engines can be shut down to a mere spark when the water-tank is full, and turned on again when the tank is empty, automatically?

A. The device represented in the drawing does not do what our correspondent asks for, which would seem to be a much more difficult thing to accomplish than to simply turn off the gas, since the hot-air pump in most common use is a single-crank engine, requiring the proper adjustment of the piston before starting.

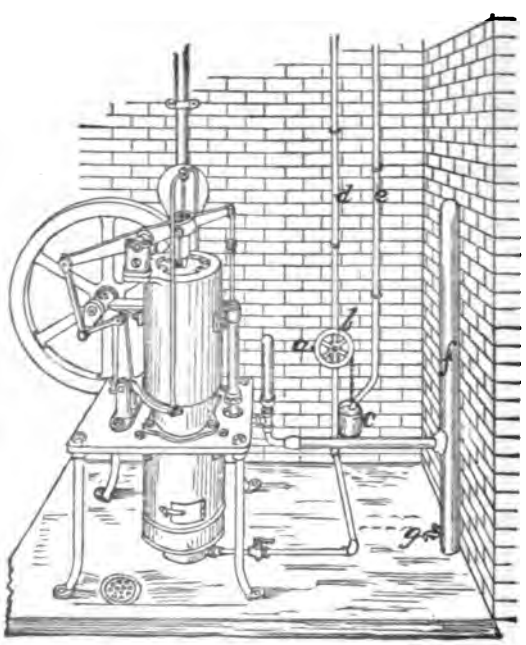


FIGURE 110.

The following is an explanation of the arrangement shown in the sketch: On the gas-pipe *d* supplying the engine is a stop-cock, on which a grooved iron wheel takes the place of a handle. A chain, attached to a pin at the point *a* in the circumference of the wheel, passes over the top and supports a small tin pail, *c*. The end of the

tank tell-tale *e* is brought over the pail, so that the weight of the water discharged into it will cause the pail to fall, thus turning the wheel and closing the valve on the gas-pipe. Before starting the pump again the pail is emptied. The large pipe *f*, shown on the right hand, is an air-chamber on the suction-pipe to supplement the smaller one attached to the pump. The stop-cock *g*, at its foot, is for removing all the water from it.

There are other devices for the same purpose, such as a small tank under the tell-tale, containing a float connected with the valve on the gas-pipe, but the arrangement shown above is simpler than anything we have seen for the purpose.

RUST IN A SUCTION-PIPE.

Q. My pump is situated about sixty feet from the cistern, with a 1-inch iron pipe for suction, but every time the pump is used a large quantity of water has to be wasted, on account of the rust in the pipe. Would you have the kindness to let me know that if I use a tin pipe in place of the iron one if it would be perfectly safe to use the water which remains in the tin pipe overnight? Would there be any danger in using lead pipe?

A. Unless there was some peculiar character to the water of which we have no knowledge, a tin pipe could be used safely. We should not recommend the use of lead pipe in such a case. It would probably be necessary to waste as much water as with the iron pipe now in use.

BAD-TASTING WATER FROM A COIL.

Q. I have been asked to try to remove a cause of bad-tasting water from a cooler. My doctor got a plumber to put a ⅜-inch galvanized-pipe coil in his ice-box, to be used for drinking-water purposes. The plumber never made one before and was not particular with it, and it tastes badly from oil and lead used in connecting it.

The coil is one foot wide, with galvanized elbows. The doctor has the water drawn from the spigot, then placed in a charcoal filterer, and then put in a stone jar, which connects with the coil for use. I have made them before, but was very particular not to use oil in cutting threads, and did not use lead to connect together. I have brought this coil which I am telling you about to my house and run concentrated lye-water through it, and then run lime-water also, and yet it tastes.

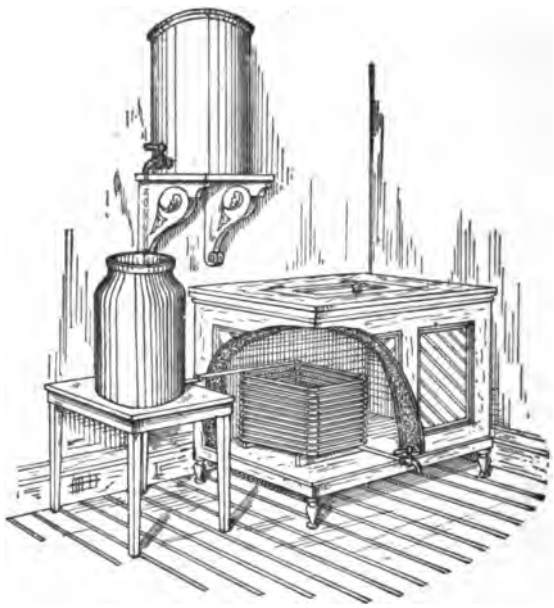


FIGURE 111.

Please inform me if you can, what to do with this coil. The doctor wants this one cleaned. The ice sits in the coil, which forms a box when connected together; the water, after it is filtered, stands in the coil and gets cold, and they draw from the spigot at the bottom for table use.

A. If the water passing through the coil tastes "badly from oil," doubtless there is oil in it, which the treatment with lye-water has failed to remove. The treatment with the alkali should be very thorough, and every part of the inside of the pipe should come in contact with it. A gentle heat—say steam at low pressure—might destroy the oil without injury to the coil.

As the coils made by our correspondent give no trouble, there obviously is one remedy left in case the above fail—that is, to throw away the oil coil and make a new one. These coils should be tin or tin-lined lead pipe and protected by a wood rack or frame.

TAR-COATED WATER-PIPE AFFECT TASTE OF WATER.

Q. I DESIRE to use some 8,000 feet 3-inch tar-coated cast-iron pipe to convey water from a mountain spring. Is there any danger of there being any taste of tar in the water?

A. There is no danger of the tar imparting a taste to the water if it is properly applied to the pipe. When water is first introduced it is better to let it run to waste for a few hours.

THE DANGER OF HAVING A WATER AND SEWER PIPE IN THE SAME TRENCH.

At various times the question has been raised as to the advisability of putting a water supply pipe in the trench that is used for the house drainage system, particularly when the latter is made of terra cotta. An experience bearing on this point is brought to our notice by James Wood, Noroton Center, Conn. One of his customers complained that the pump in the house did not work satisfactorily, with the usual vagueness as to the cause that all tradesmen are familiar with who receive orders from the public. Knowing that often the pump leathers get out of order, the valves of the pump were releathered. In this case the well was located some distance from the pump, although the water lift was but 10 feet, and the pipe bringing the water from the well to the pump in the house was run in the same trench that carried the terra cotta house drain, which had the joints in it made with lime mortar instead of Portland cement and sand, as has been found to be more durable and satisfactory.

On complaint after the pump had been repaired that it still did not give satisfaction a second visit was made to the house, when it was learned that on pumping a small quantity of water it was very offensive in smell and appearance. On continuing to pump this annoyance seemed to disappear. Being somewhat mystified as to this particular action, a sample of the offensive water and the water which came later were sent to a chemist for examination. One he pronounced to be very strongly impregnated with sewage, the other sufficiently pure for drinking purposes, with only small traces of objectionable matter such as is frequently found in water that is con-

sidered suitable for drinking purposes. This report led to an investigation and it was learned that the suction pipe was run in the same trench with the house sewer pipe. On digging up the trench it was found that the lime in the mortar, which had been used freely, had honeycombed the lead suction pipe so that it was possible for the sewage to leak into the pipe.

There being no foot valve on the suction pipe in the well, this pipe naturally was empty when the pump was not in use and allowed the sewage to leach into the pipe, and, if the pump was not used for a considerable time, in sufficient quantities to make the first water that was drawn from the pump decidedly foul and offensive. After the pump was worked long enough to thoroughly wash out the suction pipe this annoyance naturally ceased. The remedy was simple, and that was the separation of the two pipes and the substitution of a new suction pipe. It is not often that such a positive demonstration of the danger of running the water supply pipe and sewer pipe in the same trench occurs, and it can be used as an argument against the custom where it may be proposed for economical reasons.

TEST FOR POLLUTION BY CESSPOOL.

Q. A WELL is so situated with regard to a privy and cesspool that I am persuaded its water is contaminated from those sources. How can I prove it? I think I have read somewhere of a color-test, applied by introducing some color into the cesspool, and having the same color shortly appear in the water. I don't care to apply the chemical test, as it would not convince the parties using the well-water.

A. Clean out the cesspool thoroughly, then empty a barrel of coarse salt into it, and put in some water. A saline taste in the well will then indicate contamination from the cesspool.

IRREGULAR WATER-SUPPLY.

Q. THE water-works in my house act so singularly that I would like very much to have the opinion of some of your readers versed in

such matters as to the real cause of the trouble before I attempt to do anything to remedy it. I inclose a sketch of the boiler and kitchen-sink, with its hot and cold water-supply, which I hope will be of service. The difficulty is:

First—The water rises to the second floor only for a short time during the night, although the houses on each side of me have it all day on that floor.

Second—On opening the *cold-water* faucet of the kitchen-sink the water runs cold for an instant, then hot for a little time, and then cold again; and this thing goes on as long as the faucet is open.

Third—The *hot-water* faucet delivers a strong stream at first, then reduces to a mere dribble, then strong again, and so on.

You can imagine how annoying this is, and if you can do anything to solve the problem you will greatly oblige.

A. The conditions of your house-plumbing presents a singular combination, noticeably as respects the second and third difficulties.

In answer to your first point, the pipe from the street (if it is the same apparently as your neighbor's) must have at some part of its length a greatly reduced area, so that when there is a decreased pressure in the main (in the daytime) enough does not force through to give the required head within the house when a lower faucet is opened, or there is any steady drain, such as a leak, between the house and the contraction.

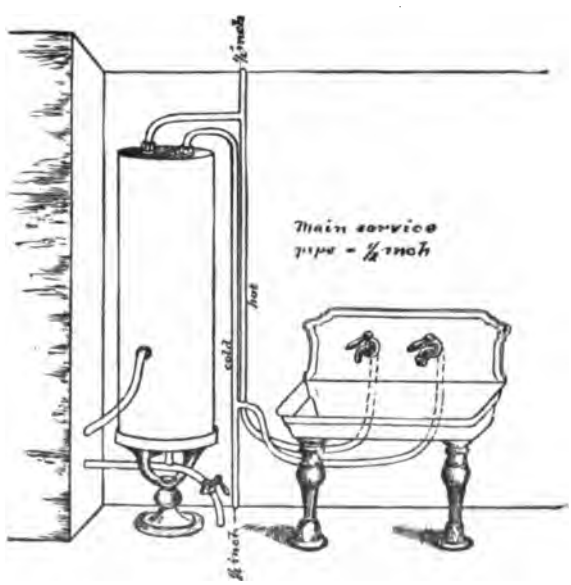


FIGURE 112.

The second difficulty is a result of the first. When you open the cold faucet the water within the pipe (cold) runs out; then in consideration of the

very small passage in the pipe, the head of water which has accumulated in the pipes above the boiler runs back through the boiler and through the cold faucet. When the water has thus run down to the top of the boiler, cold water will come again slowly in the intended direction; but it will not again repeat the operation unless the pressure within the service-pipe is subject to fluctuations, which are not likely to take place during the day, and which only can be accounted for on the supposition that you and your neighbors—one or both—are branched from the same tap, and that *you alone* have a stoppage inside the junction with their branch. The explanation just given applies also to the third question. The hot water flowing downward from the pipes in the house, passing through the boiler a little strongly at first until the head is gone, then reducing to the amount of water which will pass the obstruction—fluctuations being attributed to the same cause as before. If there is sufficient pressure in the street-mains to raise the water at all times in the house, as indicated by your neighbor, large piping will cure the trouble with a tap to yourself.

HOT WATER FROM THE COLD FAUCET, AND HOW TO PREVENT IT.

A GENTLEMAN from Brooklyn writes to confirm our views in reference to the preceding question, particularly the answer to the second difficulty, which he also experienced and which our hint sent him to investigate intelligently:

"The inclosed diagram, which I believe is a correct copy of the plumbing of a great part of the small brick residences which are being built in this city (Brooklyn), represents the principal features of the hot and cold water-supply of my house.

"You will notice that for cold water to enter the boiler it must flow past the cold-water faucet at the sink. If, now, some one opens the hot-water faucet at the bath-tub or one of the wash-bowls upstairs, and some one else goes to draw cold water at the sink, say to rinse his hands under the faucet, he is likely to take them away with a start and for a moment think he is scalded, and that he has opened the wrong faucet, but upon further trials he will find it is the faucet intended to be the cold one, and upon trying it

again he is treated to a similar experience. This I could not always repeat before I saw your answer, and when I brought persons to try my geyser I was generally disappointed, but now when I want to show any one how to draw hot water from the cold faucet I send one of my children to open a hot-water faucet upstairs.

"The reason of it is plain to me now. The ½-inch pipe from the street is not large enough to send water to the upper floor when cold water is being drawn downstairs at water-closet or wash-tubs, and the accumulated head of water in the hot pipe running upstairs flows backward (the pressure being reduced) into the boiler and over through the cold pipe and faucet until the water finds its equilibrium somewhere between the top of the boiler and the second floor.

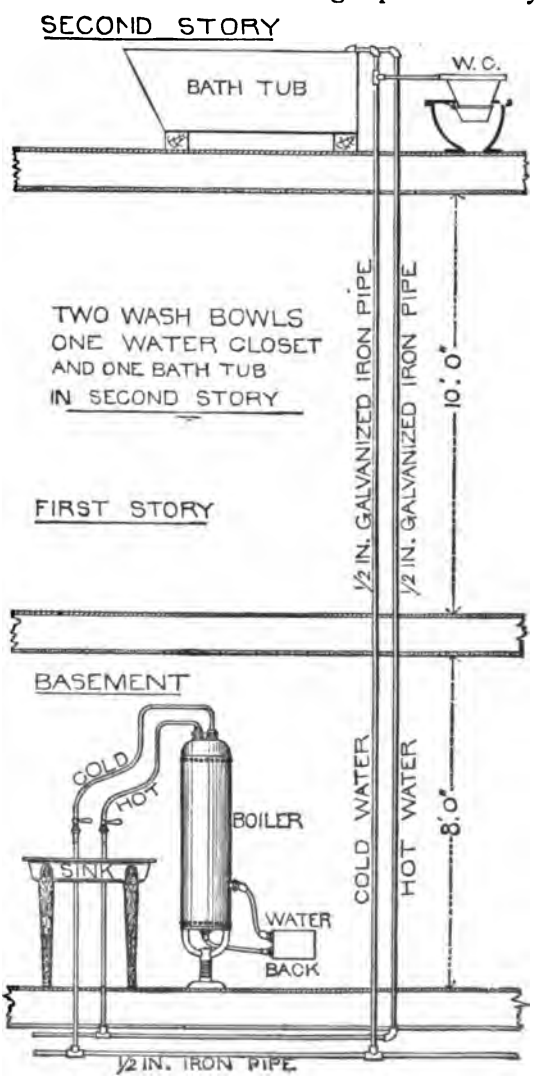


FIGURE 113.

"This can be repeated continuously, and one hand may be placed where the word *cold* is and the faucet manipulated with the other, when hot and cold water will be found to pass back and forth with each increase and decrease of pressure."

NOISE IN WATER SERVICE PIPES.

Q. I SHOULD like to know how to stop the noise in a plumbing system in a house which is fitted with a bathroom, sink in kitchen, 30-gallon boiler, etc., and all of the piping is iron, except a few short pieces at the bathtub and the sink, which are of lead. The noise starts when the engine begins to pump and ceases when the engine stops. There is a cracking, snapping and jarring of the pipes that is very unpleasant to have in a house. The main that supplies this house receives the iron pipe connection, and I think that a lead pipe connection should have been used. My remedy for the present trouble is to insert a piece of lead pipe between the iron service pipe and the street main, believing that this will prevent the vibration enough to stop the noise in the house.

A. Answering the above inquiry, we would suggest placing a piece of high pressure rubber hose between the pump and the discharge pipe. If it is inexpedient to do this the trouble can be remedied by doing the same on the house service pipe. This is a positive cure, as a hose is a nonconductor and would prevent any sound, whether caused by the pump, water meter, or any other mechanical device. We had the same trouble in a school house, where two water meters are used, the main passing up through three school rooms to a fan in the attic. At times the clicking of the meters was so loud in the different rooms that the teachers could not hear their classes. To prevent this we cut the main in the cellar and inserted a piece of hose 2 feet long.

AIR IN WATER-PIPES.

Q. I WOULD like to have the following question answered: A gentleman in the country has a well on a hill, and he runs a pipe from it to his barn. Now, he says he has to put a pump on every once in a while and pump out the air; they tell him the air gets in from the water, and I contend he has a leak in his pipe.

I would like to know if water can have air in it to stop a pipe from working, as he says.

From the top of pipe in well to top of spigot it has twelve feet of a fall.

A. There is always air in water. It is not uncommon for siphons to lose their charge in consequence of an accumulation of air in the bend. In the large 24-inch siphon-pipe at the Kansas City

Water-Works, the pipe is only kept free of air by an air-pump attached to the pumping-engine. If there were a leak in the pipe mentioned by our correspondent the pump would have to be applied a good deal oftener than once in a while.

WHY WATER IS "MILKY" WHEN FIRST DRAWN.

Q. WHAT is the cause of water when it is first drawn being just as white and thick as milk, but if you let a tumblerful of it stand for about one minute it will become as clear as you could wish? It leaves no sediment at the bottom, and you cannot by stirring or shaking, make it white again.

A. The milky appearance is probably due to air confined in the water under the pressure in the pipes, which escapes when the water runs from the faucet.

QUESTIONS IN HYDRAULICS.

Q. PLEASE give me the following rules and state whether the quantities are theoretical or actual:

A rule for finding the quantity of water discharged from pipes ⅜, ½ and ¾-inch in diameter, and of different lengths, connected with a water main in street under different pressures.

A rule for finding time and size of pipe for emptying tanks under different heads.

Rule for finding quantity of water discharged from pipes of different sizes under different heads and different lengths.

Rule for finding sizes of pipes to discharge different quantities of water with different heads and different lengths.

A. The formula for the discharge of water at different pressures from pipes of various sizes and lengths is $\sqrt{\frac{d^5 \times h}{l}} \times 4.71 = V$, in which d^5 is the fifth power of the diameter of the pipe in inches or decimals of an inch, h the height of a head of water due to the pressure in pounds per square inch in the main pipe, and l the length of the pipe in feet, 4.71 a value based on the actual flow less friction and contraction at inlet of pipe, and V = volume in cubic feet per minute. The fifth power of a ⅜-inch pipe diameter is 0.007428; for ½-inch, 0.03125, and for ¾-inch, 0.2373; for 1 inch it is 1, and for sizes above, by multiplying the size four times for the fifth power;

h, the height of head, is obtained by multiplying the pressure in pounds by 2.3. A simple example will illustrate the application of the formula, say, for a service pipe ⅜-inch diameter, 50 feet long, with 50 pounds pressure in the main pipe. The fifth power of ⅜ inch $= 0.375^5 = 0.0074$, and the height $= 50 \times 2.3 = 115$ feet head. Then the formula will be $\sqrt{\frac{0.0074 \times 115}{50}} \times 4.71 = \frac{\sqrt{0.852}}{\sqrt{50}} = \frac{0.9219}{7.071} = 0.13 \times 4.71 = 0.6123$ cubic feet per minute, and $0.6123 \times 7.5 = 4.59$ gallons per minute discharge from the ⅜ pipe with full open end.

The third question requires the same formula and operation as stated above for any size pipe.

By reversing the formula the size of the pipe diameter may be obtained for any given volume, head and length of pipe. Taking the example as above, the formula will be $\frac{\text{Volume}}{4.71} \times \sqrt{\frac{50}{115}} = \sqrt{d^5}$, and by squaring the $\sqrt{d^5}$ the fifth power of the diameter may be obtained, by which, by comparison with the fifth powers for the various sizes of pipe, the nearest size may be selected. The above formula and example will then figure as follows, for cubic feet discharged per minute: $\frac{0.6123}{4.71} = 0.13 \times \frac{7.071}{10.72} = 0.08575 = \sqrt{d^5}$; then $0.08575^5 = 0.00735$, which will be found to correspond nearly with the fifth power of 0.375, the size of ⅜-inch pipe, the dropping of extreme decimals making a small fractional difference.

TESTING WATER METERS.

Q. PLEASE let me know the simplest and surest method of testing water meters on the premises.

A. There are two methods of testing a water meter in place. As our correspondent has not explained the connection of the meter, its unit of measure in feet or gallons, or whether a house or factory supply, or direct with a boiler supply, it makes it necessary to answer the question in various ways. If a dwelling house, and the meter measure is in cubic feet, a gallon measure may be used to draw from the faucet exactly 20, 30 or 40 gallons, having previously

noted the meter reading in feet and tenths of a foot. After drawing an exact number of gallons, again take the meter reading and subtract the first reading from it. Multiply the number of gallons drawn by the weight of 1 gallon at 60 degrees, which is 8.33 pounds; divide the product by the weight of 1 cubic foot at 60 degrees, 62.3 pounds, which will give the quantity of water drawn in cubic feet, which may be compared directly with the difference in the meter reading; or, if the meter measure is in gallons, then compare the direct measure in gallons. If there is any doubt about the measure being a gallon, it may be accurately weighed empty and full of water, and the difference taken for the multiplier; or a pail may be used and the weight of water that it holds may be used for the unit of measure, multiplied by the number of pails for the whole weight, turning the weight into cubic feet or gallons, as before stated. Where a large establishment is to be tested for its meter register, a more accurate and satisfactory method is to use a platform scale, placed near a water faucet, with all other faucets or outlets absolutely closed, and all leaks or possible waste accounted for. A tight barrel on the scale may be weighed, drawn full of water and again weighed, when the weight of the water divided by 62.30, will give the number of cubic feet (or by 8.33 for gallons), which, compared with the difference in the meter readings, will indicate the error of the meter. There is sometimes a difference in meter measure when the water is drawn in large or small quantities. For testing this effect it is desirable to make three distinct tests, one with a full continuous flow, as in the barrel test; one with an interrupted flow of 1 or 2 gallons at a time, and one with a continuous small stream. A good and accurate meter should show but a very small percentage of error under the three conditions of water flow.

TANKS, FILTERS AND CISTERNS.

HOW TO CONSTRUCT A FILTERING-CISTERN.

Q. WILL you please favor me with the most approved plan for constructing a filtering-cistern, and dimensions therefor, for a family of five or six persons? The owner of the dwelling desires to use rain collected from the roof of the house for drinking purposes, in preference to that supplied by the city.

A. This is answered by S. F. Copley, as follows:

Wherever rain-water is the main-supply for family use, some means of cutting off decaying dirt from the roof, so as not to foul the cistern, should be the first consideration, that we may have water for use as pure as the rainfall, uncontaminated by rotting leaves, shingles, road-dust, etc., the amount of which is only known to those who have cleaned out a cistern or a filter after one or more years' use.

There are many ways of doing this. The most simple and inexpensive I saw in use in Norfolk, Va. It consisted of a loose elbow-joint at the end of the leader, made to turn in or out of the cistern connecting-pipe (at ground line). The rule was to keep the cistern cut off from the roof, until the rain had washed it, and the gutters cleaned before letting the water in. At first thought this would seem all that could be desired; but, like all the rest of the cut-off systems, it is not only wasteful of water, but unpleasant to attend to, as it must always be done in the wet; and when water is scarce, few people would be willing to give so large a share out of every shower for washing their roof, etc., or go out in the rain, especially on a stormy night, to turn the pipe in.

So the question was, How to have good water without loss or trouble? This was the problem I had to solve for myself two years ago, when I built the present filter, which has worked well ever since without the least loss or trouble; and, believing it a step in advance of anything of the kind, I send you the plan and section, in answer to one of your correspondents (I think Dr. J. S. Billings), who called attention to the great need of some *"automatic cut-off for*

a cistern." Its simple construction and working will be best understood by referring to the sketches. Figure 114 shows the plan and Figure 115 the section. The plan is like a long, square box (sunk in the ground), with a sloping bottom and a centre partition or trap, F, dividing it in two parts—the cut-off and a filterer. The part C next the house in Figure 114 is the cut-off, and receives the water direct from the roof through the inlet-pipe D, while the other part, B, is filled with *clean-washed sand,* with a layer of gravel and stones at the bottom, as shown at I, Figure 115, which is the top of the sand, J being the gravel and K the stone. By referring to the section, Figure 115, it will be seen that the partition, or trap, F, is raised one inch from the flagstone bottom L, while the top is above the top of the overflow-pipe E, which is also shown on the plan, M (Figure 115) being the ground line, H the water line, and A the outlet to the cistern, so that *all the water that enters the cistern must pass under and up through the sand;* while any dirt that would sink is *kept away from trap and filter by the steep slope of the bottom* and collected at N. Also, anything that would float can be seen and removed, if not carried away by the overflow. While the water remaining in this part is not only of value for the garden, being tempered and at hand, but every pailful taken out is, in fact, washing the filter by just that amount of clean water being drawn downward through the sand, washing any settlement back into the cut-off, which, if emptied and cleaned out, by throwing clean water in the filter, a thorough inspection can be had without removing or renewing the sand. This

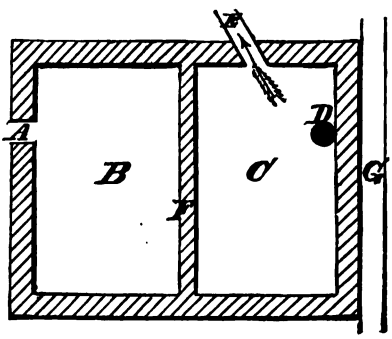


FIGURE 114.

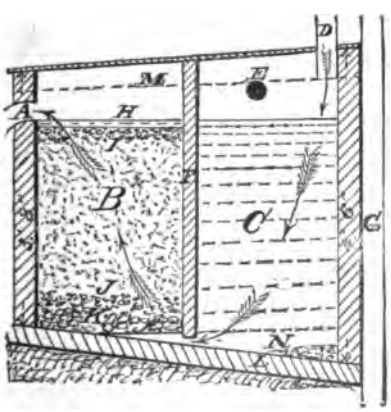


FIGURE 115.

inspection and cleaning costs but little labor, as there is nothing to decay, and so foul the water, in its construction.

For convenience and economy of construction, materials were chosen that are the most easily obtained in any village, and that would only require rough labor to build up. The bottom is formed of one flagstone, four inches thick, five feet long by four feet broad, set with a slope to the house of six inches. On this the four walls are built, four inches thick, and up to just above the ground, all laid in cement, and well coated with Portland cement on both sides (the inside floated smooth). The trap (partition) is also formed of a flagstone (in one piece), two and one-half inches thick by four feet broad and four feet high, built in the side walls and raised up one inch from the bottom. The overflow and cistern outlet-pipes are of vitrified and glazed stoneware, built in the walls, with their openings protected with wire cages against insects, while the lid is formed of matched floor-boards, made light, to be easily removed for inspection, etc.

The filter holds five and one-half barrels of sand, etc., which is washed clean before putting in, placing the stones on bottom, then the gravel—about half a barrel of each. It costs complete about $16.

Q. THE cistern-filter represented is just what I have been looking for, and I think will meet the requirements of those living in the country who depend upon cistern-water. Would it not be better to make the pipes of cast-iron, rather than of vitrified stoneware—as the former would be less likely to crack or break if they should happen to freeze? How would it do to put a faucet or valve near the bottom of reservoir C, and connect it with a pipe so that the filter could be emptied by allowing water to soak away into the ground?

A. We referred the above to Mr. F. S. Copley, who designed the filter in question, and he sends this reply:

"I do not think iron would be as good as stoneware, as the pipes are empty. The iron would rust and discolor the water, and spoil it for laundry use; and last winter's frosts have not broken or cracked mine, although in wet ground. As to putting a valve or faucet in the bottom of cut-off, I think the dirt (road-dust alone) would choke and fill the pipe up in a season, to say nothing of the loss of so much *tempered water,* which every florist too well knows the value of to waste, especially when enriched with road-dust, etc."

CISTERN FILTER.

Q. WILL you kindly advise me of the best way to make a filter for a cistern? The water is to course from a roof and I would like to filter the same before it enters the cistern. Or would it be better to have it made in two parts, divided by a wall, so that the water would filter through same?

A. We give herewith a sketch of a kind of cistern filter which has been found very satisfactory. Although it has been used mostly in connection with round cisterns, it can readily be used in connection with filters of other shapes. The cistern should be built of the desired size and coated on the inside with cement mortar ½ inch thick. The cistern should be allowed to stand until it is hard and dry enough to hold a man's weight, and then some short boards should be placed in the bottom to stand on.

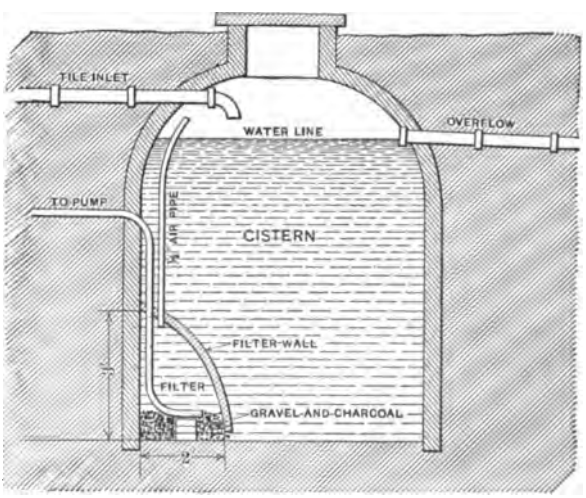


FIGURE 116.

It is best when made to occupy but a small section of a round cistern and to assume a beehive shape. After a few courses of brick have been laid, place three bricks in the middle of the filter chamber for the pump pipe to rest on; then take a pail of gravel and a pail of charcoal broken about the size of black walnuts and pour it into the chamber and spread it around so that the top of the bricks is above the charcoal and gravel. Place the perforated end of the pump pipe on the brick, as shown in Figure 116, and continue the filter wall, arching it over through the side wall of the cistern. Don't coat the filter chamber when finished with the cement mortar. The

brick will filter the water. Have the pump pipe pass out of the cistern wall just before the arch is turned to form the top. The inlet pipe and the outlet pipe should connect with the cistern near the crown of the arch, and the inlet pipe should always be a few inches higher than the outlet pipe. Tile pipe should be used for both of these connections so that they can be cemented securely to the wall. The connections in the tile pipe should be calked with oakum to prevent the cement used in filling the hub from entering the pipe and obstructing it. There is an advantage in having an air pipe of ½-inch galvanized iron or lead pipe run from the top of the filter chamber to the point above the water line in the cistern and having the upper end protected by a wire guard.

The filter chamber should extend in from the cement wall about 2 feet at the widest point, and should extend up so as to connect with the side wall of the cistern about 3 feet above the bottom. Galvanized pipe is best for the pump pipe. If lead pipe is used care should be taken in making the bend, and also in protecting the pipe against sagging from its own weight. The pipe should also be filled with sand so that it will not flatten out at the point where it is bent.

Such a filter arrangement with gravel and charcoal and air pipe will keep the water in the cistern pure and sweet. The cistern should be made with a mouth at the top large enough so that a man can readily enter. The opening should be covered with a flat stone laid in cement. This will enable the cistern to be cleaned. In the course of four or five years the filter wall should be taken down and cleaned carefully and new charcoal placed in it after the chamber and bricks have been thoroughly cleaned.

THE CONSTRUCTION OF A CISTERN UNDER A HOUSE.

Q. WILL you have the kindness to give me your opinion as to the best manner of remedying the following? A party has a cistern under his house. A brick floor and the foundation-walls cemented form this cistern; the joist and floor of same form the cover or top. The cistern not being arched with bricks, at times there is an offensive odor of decayed mud coming up through the manhole. Now, the owner wishes to abolish this cistern. It was suggested to fill it up with earth. Would it be prudent to do so,

would it be better to thoroughly dry this cistern and whitewash the walls, etc.? If you can suggest any better way you will greatly oblige.

A. It will be best to fill the cistern with clean, dry earth, since if it is left empty there will always be a certain element of danger connected with it, unless it is used for some purpose, and its presence thus kept constantly in mind. If it is left empty, means should be provided for its ventilation in the form of two tubes, one opening into it near the top, the other near the bottom, and both communicating with the external air.

Care must be taken that the earth used for filling does not contain organic matter; a mixture of equal parts of clean sand or gravel and clean clay is better than either alone would be. If the level of the subsoil water in the vicinity is below that of the bottom of the cistern, the cement bottom should be broken up before the cistern is filled, in order that the earth within and without may communicate freely.

Q. I AM building a cistern under my house to contain rain-water which will be used for drinking, etc. I wish to put in a terra-cotta pipe through the top to the bottom of the cistern in order to deposit the fresh water at the bottom. Would the terra-cotta pipe be in any way injurious to the water?

A. Terra-cotta pipe will not injure the water for drinking purposes, but it is highly unadvisable to place a cistern under a dwelling-house, since by doing so one runs a triple risk—viz., of injuring the house by dampness; of injuring the health of the inmates of the house, especially if any of them have a tendency, however slight, to lung disease; and lastly, of injuring the water by placing it where it can absorb the organic and ammoniacal exhalations connected with the presence of animal life.

HOW TO FIT SHEET-LEAD IN A LARGE TANK.

Q. To SETTLE a dispute, will you inform me, if it is not too much trouble, the proper way lead should be fitted in a tank for wiped seams in the corners?

A. Much depends on size of tank and weight of lead. A tank is say 8 feet long by 6 x 6 feet of 6-lb. lead. Order the lead to be

rolled—one piece for bottom, 8 x 6 feet, two pieces each, 14 x 6 feet 1 inch, rolled up separately. Then countersink about two feet apart in sides and ends, for dots to secure the lead to, dots to be about half an inch deep and two and a half inches in diameter. Then nail into two of the opposite upright corners hollowed strips of wood, but previously unroll the bottom in place and dress it down. Then take one of the side and end rolls and turn half an inch of the edge; set the roll on end in the tank, placing the turned edge in one of the square corners; brace it from opposite side; unroll the sheet in place; then take a strip of board one-quarter of an inch thick, tack it temporarily on top edge of tank; dress over the edge of the lead; then remove the wood strips, previously bringing slightly forward the lead at the bottom; remove the strips and tack the top edge securely, and dress all around; bottom corner to be beaten in with chase-wedge. This will leave one-quarter of an inch to close the seams. Back of ladle can be used to dress the lead into the dots.

After the other side and end are in place, prepare the dots for wiping, and drive in a few tacks to keep the lead in place; then drive in a stout iron screw in each dot, allowing the head to project slightly; then wipe the dots, and while the metal is being reheated prepare the upright seams, which will next be wiped, and proceed in like manner with the bottom corners.

Avoid tinned tacks, as zinc is more or less in the metal used in tinning them. Small tanks for water-closets and other purposes can have bottom and two sides in one piece, which will be put in first.

Q. I have read your reply to my inquiries regarding the proper way lead should be fitted in a tank for wiped seams in the corners, and I beg to differ with your ideas of lining tanks with sheet-lead in the manner you have here described. In the first place, your idea of first dressing the lead into place in the tank before preparing the edges of the lead for wiped seams in the corners seems to me to be rather a bungling way of going about it, as there cannot be as neat or as good a job made of preparing the seams in the corners after the lead is in place in the tank as can be made before the lead is put in place.

Now, my idea of lining a tank of the size you have here described, 8 feet by 6 x 6 feet, is: Cut the lead in the same manner as you have described, cutting one piece of lead for the bottom 8 x 6 feet, cutting the edges of the lead perfectly true. Then cut two pieces, each making a side and end; these two pieces should be cut the exact size, so as to fit snugly into the corners of the tank when

in place; then proceed to prepare the seams by first rolling out the bottom piece on the floor and dressing around the edges. Next measure in four inches from the edge for width of soiling and mark line with straight-edge; then run chalk on 4-inch space to be soiled, so as to take off the greasy surface of the lead. Now, having a pot of good hot soil ready, proceed and soil to the line four inches wide all around. While the soil is drying mark off the dots in tank, two feet apart; countersink them half an inch deep and two and a half inches in diameter—just as you have described—and proceed to shave the seams by first marking off the width of seam, say three-quarters, seven-eighths, or one-half inch in width according to whatever width one prefers having it. Then mark a line on each edge with a straight-edge, then placing the straight-edge under the lead a little in from the edge, shave the lead to the line on the four edges, and level off the edges of the lead with the shave-hook all around. Then roll up the lead, place it in the tank, and unroll in place. Nail into two of the opposite corners strips of wood so as to make rounding corners where no seams are wiped, then prepare the seams on the two pieces to make the sides and ends in the same manner as the bottom, shaving the bottom edge and ends and beveling off the edge of the lead with the shave-hook. Roll up the lead and place two thin boards in the bottom of the tank, one down the side and one across the end, close to side of tank. Set the roll on end in tank, placing the beveled edge of the lead snugly in the corner of the tank, brace it from opposite side and unroll in place, dress in bottom edge and slip the boards from under, letting the lead settle down snugly into place. Then dress over top edge on tank and tack down securely. Proceed in like manner with the other piece. When all are in place forming close mitre-joints in the corners of the tanks, drive in the tacks in the joints in the corners, catching on both edges of the lead and setting them in pretty well, giving a good opportunity to properly cover over the heads of the nails when wiping the seams. Dress the lead well to the sides of the tank, having the metal and irons good and hot; grease the seams and proceed to wipe. While the metal is being reheated dress the lead into the dots in the tank on sides and ends with back of ladle, striking a circle with the compass, then soil and shave to the edge of countersink to secure the lead to dots. Put in two or three good screws, being careful not to set them up too snug to the lead, and wipe them over flush. In this way a good, first-class and neat job can be done; but, after all, much the easiest way to line such tanks is to put in each piece separately, wipe down the four corners, and around the bottom. It takes a little more solder, but I never could see the use of turning the edge in the corner to close the joint, as the proper place for the tacks is in the corner, and you leave one-quarter of an inch to close the seams of bottom corners. It is in the way in wiping a nice seam, for you have to look out that it is properly covered over with the solder.

A. At Mr. ———'s request we gave our opinion on the proper way lead should be fitted in a tank for wiped seams. After having asked for and received our reply, Mr. ——— sends us his own views, as above.

We venture to say that if he has ever lined a tank 8 feet by 6 x 6 feet, or one-half that size, previously preparing the seams for wiping, without having afterward had to soil shave them when the lead is in place, it is the first one that has been done without making a "bungling" job—such as he has been pleased to call our method of doing it. Mitering the lead in the corners, as he describes, cannot be done without leaving openings for the solder to run under the lead, thereby causing its bulging, which would crack the seams as fast as wiped. The further the tacks are set in as described the more solder would run under the lead, and instead of fifty pounds, which should be a sufficient quantity to make a good job, twice that amount would be consumed, and but poor work obtained with the best hand at the cloth.

TO PROTECT LEAD LINING OF A TANK, AND CAUSE OF SWEATING.

Q. WHAT is considered the best receipt for coating a lead-lined tank to preserve the lead and prevent sweating?

A. Pure waters act upon lead more energetically than those containing carbonates. Water containing carbonates will form a carbonate of lead coating in the tank, and so prevent or retard the solution of the lead. We know of no instance where this has been practically applied. By the sweating in this case we presume you mean the condensation of water on the outside due to the lower temperature of the water as compared with that of the surrounding atmosphere. This cannot be helped, and in good work safes are provided under the tanks to catch this water of condensation.

PAINT TO PROTECT TANK LININGS.

Q. PLEASE inform me of the best mixture of paint to use on lead-lining of tanks. The lining is full of pin-holes, and has only

been in use a year. It is lined with 6-pound sheet-lead. The tank is used for supplying water-closets.

A. We know of nothing better than Paraffine varnish. There are two different articles sold as "black varnish." One has a basis of coal-tar, and when used may be diluted with naphtha; the other has a basis of natural asphalt, and may be diluted with spirits of turpentine. We do not know that one is more durable than the other. The tank should be perfectly dry when the paint is applied. We do not know how long, at the longest, such a coating will last, but it can be renewed at a trifling expense whenever the tank is cleaned.

STOPPING LEAKS IN LEAD TANKS.

Q. I SHOULD like to learn how to locate a leak in a lead-lined tank which is well soldered. The tank is all right when it is filled up to 11 inches, but after that it soon begins to leak.

A. First take a piece of hardwood and a hammer and go over all the seams, letting the block extend over the solder of the wiped seams enough so that when the hammer is used it will drive the solder tight up against the lead and stop any small places where the solder has not taken properly. If this is done carefully some of the leaks may be found that are giving trouble and they can be soldered tight. After this is done put a lot of bran in the tank and fill it up from the bottom slowly. The bran will find its way into the small leaks and stop them effectually. Leaks that had proven very troublesome have been stopped by this means in tanks that have now been in service many years.

LEAKY CEMENT TANKS.

Q. A CUSTOMER has a cold storage building and in the basement are about 30 vats used for pickling eggs. They are built of brick and on the solid rock. They are about 8 feet long, 6 feet wide and 4 feet deep. The brick is laid in the best Portland cement and thoroughly grouted and coated on the inside with the same. They hold the water for a short time—about a month, and then start to leak. If the leaks cannot be stopped by cementing what

would be the best material to use to line them with? Lime is employed in the pickling process. What is the proper way to apply the cement?

A. Any material used in an egg pickling tank must be free from odor or any contaminating effect upon the lime solution. There is a possibility that the lime water may have a disintegrating effect upon the Portland cement. If this is so, it should be known by the appearance of the surface of the walls when the tank is entered. If the walls are still hard and smooth the only process that we can recommend that will not affect the eggs by its odor is paraffine, to be applied as follows: Clean and dry the inner walls of the tank as dry as possible, or so that the paraffine will penetrate at least from ¼ to ½ inch into the cement by heat. Warm the walls with a plumbers' blow-pipe just enough to receive and hold the melted paraffine applied with a brush, and continue the heat long enough to drive the paraffine into the cement. The blow-pipe should be held at a distance to prevent overheating or burning of the paraffine. This operation is somewhat tedious, but it is, we believe, a reliable way of accomplishing the desired object.

HOW TO CONSTRUCT A SUNKEN RESERVOIR TO HOLD TWO THOUSAND GALLONS.

Q. GIVEN a spring on a high hill, in a country of severe winters, how is it best to form a 2,000-gallon reservoir at the spring (to accumulate and to be free from pollution of anything thrown in), and to conduct the same to a tank on top of a house at a lower point?

If the reservoir is sunk, what shall it be not to rot? Will it then gather all the water readily? If *above* ground, what will last best, etc.? Anybody who is experienced in this line, please post me, and as to winter effects.

A. Sink a cask well tarred on the outside for a small reservoir. If it must hold 2,000 gallons, make a brick well eight feet in diameter and six feet deep, and roof it over.

CONSTRUCTION OF A HOUSE-TANK.

THE tanks are on the top floors, and are built with a view to distribute the weight evenly over a great many joists, and for this reason they are but five feet wide by fourteen feet in length, the depth being five feet.

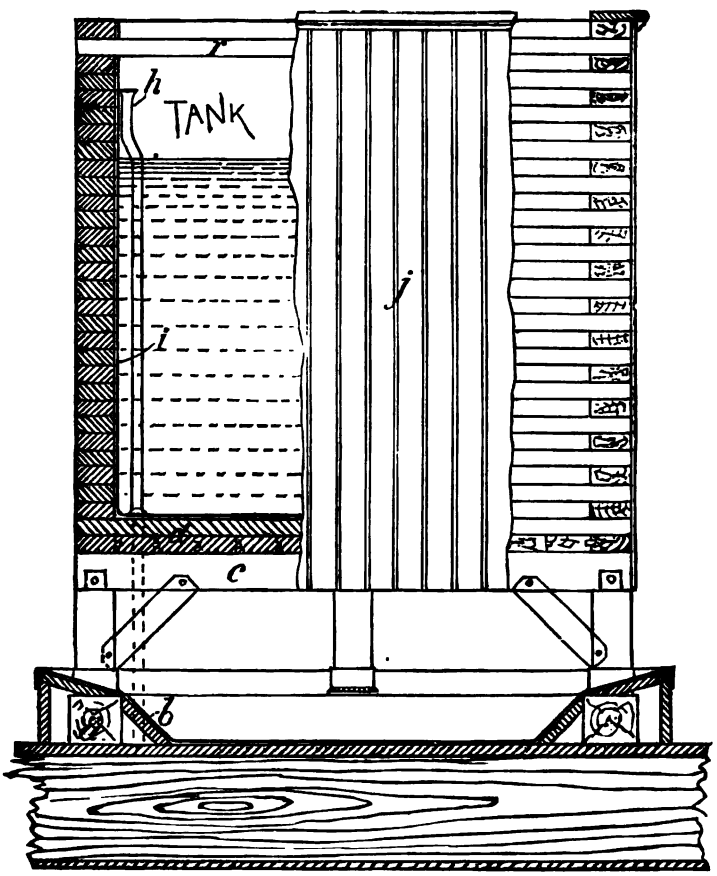


FIGURE 117.

The particulars are: A sill, *a*, 6″x6″, made of spruce, with its centre under the centre of the walls of a tank, is carried all the way around upon the floor. Into this sill are set the trusses *c*, the height from the floor to the top of the truss being two feet, and the distance between the centres of the trusses three feet. The trusses are

braced as shown and mortised into the sill, all mortises and tenons being draw-bored and treenailed. On these trusses a deck or bottom, *d*, is formed by two thicknesses of spruce plank 1⅞ inches thick by 4 inches wide when planed. They are laid in contrary directions, the first layer being across the trusses, and are nailed and clinched. The sides and ends of a tank are formed by spruce planks 4 inches wide by 1⅞ inches thick when planed, built on their flat from the bottom up, in the manner shown in Figure 118, which we believe is nearly the same as in the construction of grain-elevator bins. The courses are laid *one* at a time and spiked to the ones next below them; 6-inch spikes being used, so that the point will always enter the fourth plank. This, it will be seen, gives a solid thickness of *four* inches to the side of the tank, and it is claimed, on account of the manner of constructing the corners, that it gives greater strength and stability than if 4-inch thick plank were used on their edge, and requires no strapping.

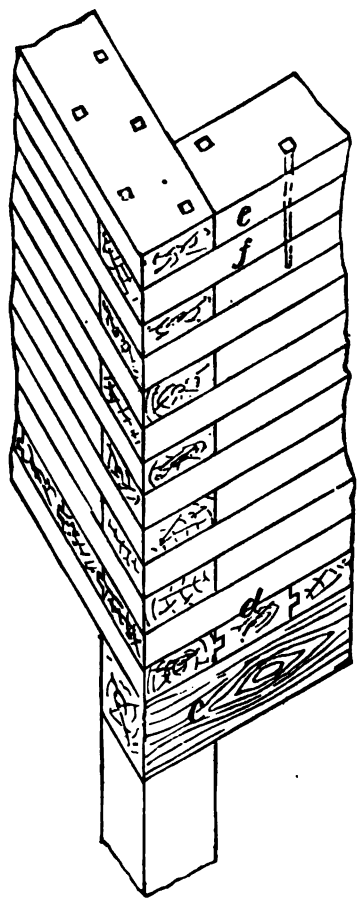


FIGURE 118.

In the long direction of the tank wooden stays, *r*, are introduced to prevent straining on the long sides when full of water. This wooden tank thus formed is lined with 18-ounce tinned copper, which is carried to the top of the wood-work. The outside of the tank is cased with yellow pine match-boarding (*i*).

The tank-safe is formed, as shown at *b*, by giving the space bounded by the sill an appropriate incline with wood, and extending

it over and beyond the outer edge of the tank, and lining it with *four*-pound lead.

Between the *two* tanks (one being in each house) an arrangement of piping is made whereby the water from the tank in any one house may be used in the other should either the tanks or service-pipes be out of order or one of the pumps be inoperative.

CLEANING A HOUSE TANK.

BY D. F. N.

A GREAT deal of damage is often done to a good plumbing system through ignorance or negligence on the part of the owners or engineers of buildings by not taking proper precautions when cleaning a house tank. When the water shows itself murky, instead of employing a plumber to see that the tank is cleaned in the proper manner the owner, particularly of a private dwelling, will often send some servant up to clean the tank. This is a kind of job that is distasteful and it is hurried through with as soon as possible. The water supply is shut off, then all the water is drawn off from the tank at some one of the different fixtures in the bath-room below. When the sediment or mud, which has settled at the bottom of the tank, is reached, a servant takes pains to sweep or force down the falling supply line as much of the mud as he can, being ignorant of the result of such work. The disadvantage of this course will show itself as soon as the tank is filled again. All of the cold supply lines to bathrooms and under floors will be found to be more or less choked with mud, and also the water back in the kitchen ranges. An instance has come under my observation where the tank had not been cleaned for a long time and slimy mud had formed above the outlet and stopped it up. It was cleaned carelessly, as described, and many of the cold water supply pipes were filled with mud, making several days' work for the plumber to clear them. The proper way to clean a tank is to empty it to within about 6 inches from the bottom and close all of the pipe openings with round, tapered soft wood plugs. The solid matter should then be removed and the tank scrubbed and the dirty water taken up in pails and poured into the gutter. The solid mud can be disposed of in the ash cans. This method prevents the pipes from being choked and insures the tank being clean.

LEAKS IN COPPER TANK SEAMS.

Q. CAN you give me a remedy for or a method of stopping leaks in a copper tank which is 10 x 10 feet and 2½ feet deep? The water seems to destroy the solder. This tank has been lined twice with galvanized iron and is now lined with sheet copper. It stands all right, except in the bottom seams. In putting in the bottom the seam was just lap nailed and soldered, instead of being locked. The solder in the bottom only lasts one year. Is there any kind of paint that will keep the action of the water from the solder?

A. There can be no doubt but what the seams in the tank should have been closely nailed and locked and then heavily soldered. This would have given strength, but would not necessarily have prevented the trouble reported. Various materials have been used to protect the solder in tanks where a corrosive action has so affected it that leaks were soon noted. One is to coat the part soldered heavily with a mixture of beeswax and rosin, or paraffine and rosin, while some use paraffine alone. It is recommended that the mixture be melted and applied to the seams hot with a paint brush. This heats the metal to a certain extent and allows the fluid to penetrate all crevices, and prevents the water coming in contact with the metal. Some coat the soldered portion with a good quality of asphaltum varnish, and it is not uncommon to paint the entire inside surface of tanks with hot paraffine. Another method is to heat the surface of the tank with a torch, so that the paraffine would more readily coat the metal. We think if our correspondent will solder his tank again carefully, putting on enough solder to make the seams strong, and then paint the seams freely with one of these mixtures, that it will be some time before leaks are again noticed.

CAPACITY OF PARTLY FILLED TANK.

Q. PLEASE let me know of a rule for figuring the capacity of a partly filled cylindrical oil tank, lying on one side. We have a tank here at the railroad shops used for fuel only. The length of the tank is 338 inches, diameter 84 inches, and it contains a depth of 21½ inches of oil.

A. The whole problem in Figure 119, it will be readily understood, consists in finding the area of the figure B D C E. After find-

ing that area multiply it by the length, or 338 inches, which gives the cubic inches of oil in the partly filled tank. Divide this finally by 231, the cubic inches in a gallon, when we get the capacity in gallons. There are several rules that may be applied in obtaining this area. for the benefit of our correspondent, however, we will refer to but two methods. The first, which is the simplest if the proper books are at hand, is to use what is known as a table of areas of circular segments, the figure B D C E being what is known as a segment. These tables are to be found in engineering pocket books. In applying such a table we first divide the rise E D, which is 21½ inches, by the diameter of the circle, which is 84 inches, the result being 0.256. Looking down the columns opposite this number we find the number 0.15876, and multiplying this by the square of the diameter, or 7056, we have the product 1120.19056 for the area of the portion B D C E. Calling this for short 1120.2, and multiplying by 338, the length of the tank, gives 378,627.6, which is the total amount of oil in cubic inches. Dividing this by 231 gives 1639, which is the contents of the partly filled tank in gallons.

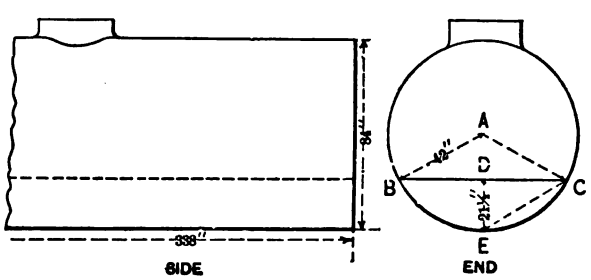


FIGURE 119.

This answers our correspondent's question so far as the capacity is concerned; but he asked for a rule, and the following is the same problem figured out by formula: Figured out in this way we first obtain the area of A B E C, and from that subtract the area of the triangle A B C, the result being the area of the portion B D C E. The area of A B E C is equal to the length of the arc B E C multiplied by half the radius, 42. It is necessary, however, to find the length of the arc B E C, and to do this we must first find the length of the straight line E C, which is known as the chord of half of the arc B E C. The length E C is equal to the square root of the diameter 84 multiplied by the distance E D, or 21½. The square root of the product of these two numbers is 42.5. Now to find the length of the arc D E C. It is equal to

twice the distance E C, or 85, multiplied by ten times the distance E D, or 215; and the product divided by 60 times the diameter, or 5040, less 27 times E D, or 580.5. The result of this division is 4.1, and to this must be added twice the distance E C, or 85, giving for the length of the arc B E C 89.1 inches. Having now the length of the arc B E C, and referring to the rule above quoted, multiply this 89.1 by one-half of the radius of the arc, or 21, which gives us for the area of A B E C 1871.1. From this we have to subtract the area of the triangle A B C; but to find this we must determine the length of the chord B C. To do this we have to apply a formula, from which we find the length of the chord to be 73.3 inches. The area of the triangle is found by multiplying one-half of this distance, or 36.65 inches, by the difference between the radius, or 42 inches, and the distance D E, or 21.5 inches, which is 20.5 inches. Multiplying these two together gives the area 751.3, and subtracting that from the above determined area of A B E C, or 1871.1, we have the remainder 1119.8 for the area of the portion B D E C. This, it will be seen, is a trifle smaller than what was obtained from the tables. Multiplying this by the length of the tank, or 338, gives us for the total quantity of oil in cubic inches 378,492.4, which is about ½ gallon less than was obtained from the tables. These differences, it should be explained, are due to the use of different formulas, some of which are only approximate, and also to the leaving off of final decimal places. We think, however, that the two answers correspond near enough for all practical purposes.

MISCELLANEOUS

APPARATUS FOR COOLING WATER.

Q. I HAVE had a call from a manufacturer to devise some means of supplying a quantity of iced water at about 45 degrees Fahrenheit, with as little possible loss from friction due to coils, &c. The quantity of water is about 15 gallons per operation through a ½-inch nozzle, the maximum operations being about six per hour and about 30 per day of nine hours. The water when used is about 55 degrees Fahrenheit, using the main water supply to increase the temperature, the supply from the main in the summer being about 65 degrees. My idea is to have two cylinders made about 4 feet long to contain about 25 gallons of water each, with large inlets and outlets to reduce the friction. I would place these cylinders horizontally in a tank of water (well insulated), 6 feet long and 3 feet wide, placing the ice on top of the cylinder so as to be immersed in about 3 inches of water and so immediately chill the water that enters the cylinders. In my experiments I found that placing ice on a small cylinder and allowing the drippings to run off as in a refrigerator is not at all effective. I believe that to chill the water as I intend to will take about 400 pounds of ice, and this I think is too much to obtain the object desired. As this water is to be used every day would it be practicable to use a small ice machine or apparatus, not to make the ice, but to chill the water in the tank? If this is practicable I would be glad to have some particulars, as I am quite ignorant on the subject. Are there any publications that relate to work of this kind from which I could get some data to proceed on? Would better results be obtained by putting, say, about 400 pounds of ice into a 250-gallon boiler or tank, such as is used to heat water for large buildings and flats, making use of the two manholes on top for putting in the ice? The objection to this plan would be the trouble of shutting off the water each time the ice was needed. If, however, better results can be obtained by this plan the objection to shutting off the water would not be a serious one.

A. Supposing that our correspondent requires the water to be used at a constant temperature of 45 degrees, we do not find that the two cylinders that are suggested, nor any small coil arrangement, will meet the requirement of the intermittent use of the water as stated. By any such arrangement the tanks or a small coil filled with water, after standing during the intervals between the times of using the water, would with the water they contained become too cold and the water entering during the drawing of the water would not sufficiently change in temperature, so that there would be no equality of temperature in the water drawn. With the view of a

day's supply of even temperature water we suggest a large round wooden tank, say 6 feet diameter, 4 feet high, thoroughly insulated bottom and sides. Place in the tank a bent coil of 2-inch pipe, say 100 feet in length, which will hold 20 gallons of water and expose 60 square feet of cooling surface. Place an overflow to the tank and fill it with water, say 500 gallons, at an average temperature of 60 degrees F., say 3750 pounds. To cool the water and coil filled with water to 45 degrees will require 450 pounds of ice for the first charge, which should be made at night. This will cool the whole body of water, coil and contained water, to a little below 45 degrees, when the day's operations can commence. For each time that 25 gallons of water are drawn from 13 to 18 pounds of ice should be added to the tank, according to the variation in the supply temperature, which will keep the water in the tank at a nearly constant temperature of about 42 degrees, the large body of water in the tank so equalizing the temperature of the water drawn that it will not vary more than 2 or 3 degrees. The daily use of ice will then be about 450 pounds, which will be much cheaper than to run a small refrigerating machine.

LARGE CAPACITY WATER COOLERS.

THE comfort derived from cool water for drinking purposes has always been appreciated, but at the present time it is considered indispensable in the hot seasons. The expense of the ice bill when ice is used for cooling purposes reaches a considerable figure in factories, hotels and restaurants. Some of the devices used to reduce this expense and to furnish an ample supply of water are shown in the accompanying illustrations. Figure 120 shows an apparatus built for use in a large restaurant in New York, where about 6000

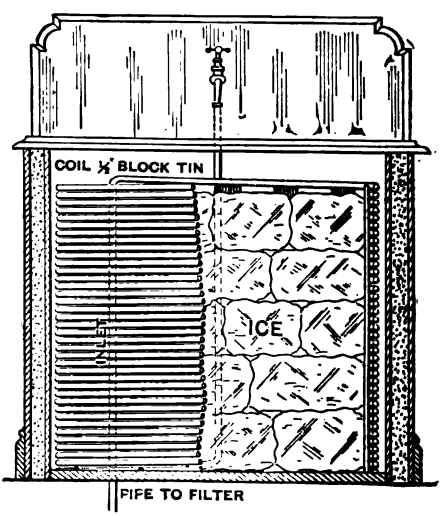


FIGURE 120.
A Restaurant Cooler.

people are served within the space of two hours at midday. It consists of a large box lined with tinned sheet copper, the inside dimensions being about 12 inches wide, 30 inches long and 30 inches deep. In the box a coil of ½-inch block tin pipe was used, through which the water passed. This was wound around the box until about 150 feet of pipe was used. Water was brought in from the street main to a filter, and after passing through the filter was connected to the coil at the top. The water after passing through the coil of pipe was conveyed through a pipe to a faucet where it was drawn as required, and in the restaurant ran almost continuously at midday. In order to protect the pipe from being crushed by the ice that filled the box a wooden frame work was placed in front of the coil of pipe. It is said that from 25 to 33 1-3 per cent. of the ice bill was saved by this method of cooling the water over the previous method of having large pitchers on the restaurant tables filled with small pieces of ice, or the use of a large water cooler into which the ice was placed with the water which was drawn through a faucet. The satisfaction attending the use of this device has been infinitely greater than that of either of the more primitive methods mentioned.

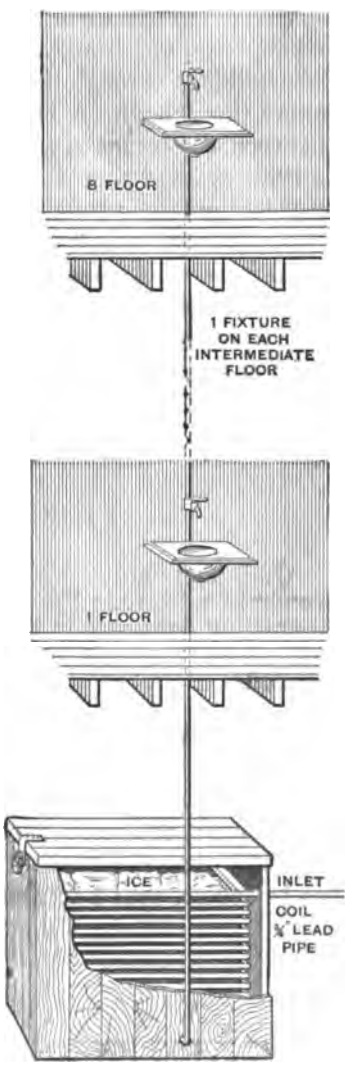


FIGURE 121.
Cooler for a Building Having Several Floors.

In the second apparatus, shown in Figure 121, an icebox was placed in the basement of an eight-story building in which about 100 hands are employed on each of its floors.

The box is about 3½ feet deep, 3½ feet wide and 6 feet long, and has a cover which is secured by means of a padlock after the box is filled with ice. About 300 feet of ¾-inch lead pipe is used in this box, the water from the street main being brought into the top of the coil and the pipe continued from the other end of the coil up to the top story of the building, through the toilet rooms, which are directly over one another throughout. A branch is taken off the pipe in each of the toilet rooms by means of a long faucet, which drips immediately over the lavatory bowl should a leak occur. The box is made to hold a ton of ice, and the calculation is that when filled on Monday morning and the cover locked down tight, there will be no need of replenishing the ice for a whole week. By this means cool water is abundantly supplied the employees as required, there is no danger of the ice being abstracted in small pieces, and at the same time the labor of attending to several water coolers is avoided.

STOREHOUSE FOR ICE.

Q. Is there any objection to making a storehouse for ice under a corner of a house in the country; can the ice be stored there without creating dampness in the vicinity, and will it keep as well as if stored in buildings for the purpose? What is the best plan of construction?

A. Ice should never be stowed under a dwelling. Its constant drainage and condensation of vapor from the surrounding air keeps everything damp. Ice is found to keep best when packed in masses above ground, and surrounded by a double boarded frame, filled with sawdust or shavings, to check the circulation of air. The roof should also be double, with a confined air-space between the sheathings.

CONNECTING REFRIGERATOR-WASTES WITH DRAINS.

Q. I HAVE frequently read your warnings about connecting refrigerator wastes to the drain, so I had mine arranged as shown by the accompanying sketch, which may interest some of your readers and call out suggestions as to how it can be improved.

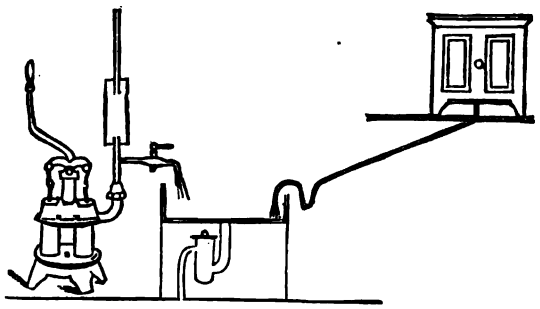


FIGURE 122.

A. The arrangement seems a very good one. If the trap was placed close to the refrigerator it might prevent the ice melting so rapidly.

DISPOSING OF REFRIGERATOR-WASTES.

Q. WE herewith hand you a sketch of the method we use in draining our refrigerators where a connection is made with the drain of the house. In this manner we trap the pipe at A, when the water comes from the refrigerator, by using a siphon. From this the water drops into drip-pan B, which is again trapped (by a siphon, C); thence the water drips into another drip-pan D, which is also trapped

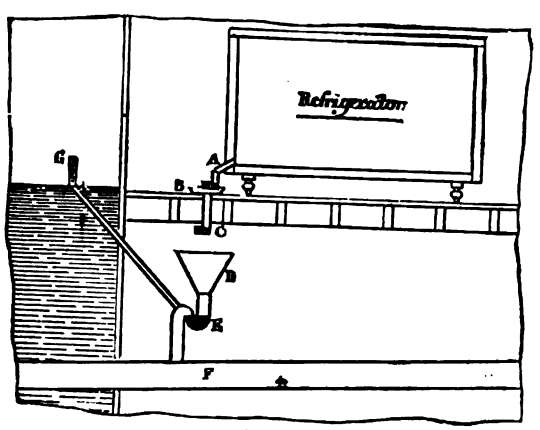


FIGURE 123.

at E. This being a confined trap, we ventilate the trap through pipe with opening out of doors at G. This method we consider perfectly safe, but would be exceedingly obliged for your valuable opinion of it.

A. This method of disconnecting the refrigerator-waste from the drain, and at the same time preventing the ascent of cellar-air into the floor above and into the refrigerator, is a good one, provided some certain means are taken to maintain the seal in the trap E, when ice is not melting, as in winter. We fear the average servant cannot be depended on to always attend to this. If, therefore, the drip from the lower so-called siphon C were into a sink having some other source of supply than the melting ice, the plan would be improved.

ARRANGEMENT OF SAFE-WASTES.

THE arrangement shown in Figure 124 gives a view in the cellar where the "safe-wastes" are brought together over a sink. The pipes *f* are the safe-waste pipes from the principal divisions of the

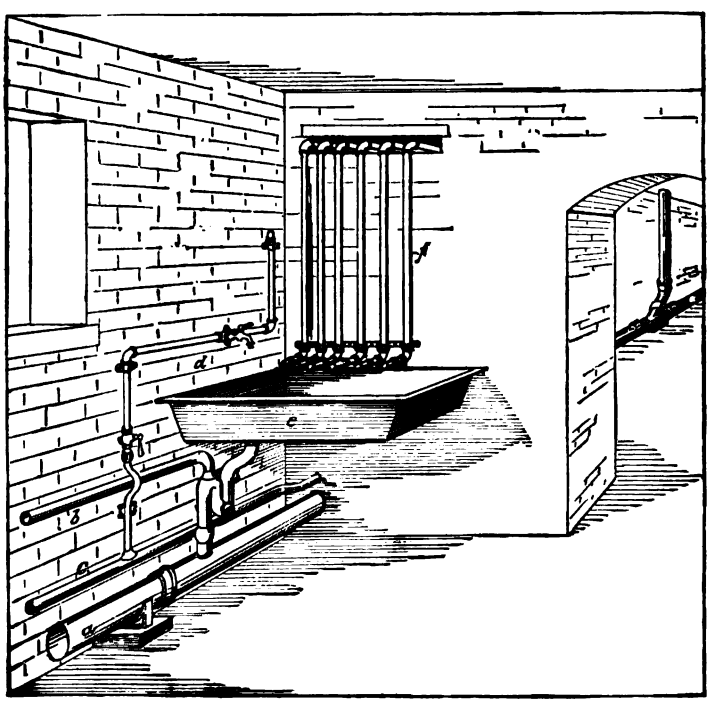


FIGURE 124.

house. At their ends over the sink they are furnished with "swing" check-valves to prevent a current of air from the cellar passing up

them. The sink is galvanized, and is let into the wall at the end and back, and leaded so as to dispense with a leg at the outer corner. The arrangement of the trap and vent (*b*) is shown, as well as the main water-pipe (C), with its branch (*d*), and part of the house-drain, *a*.

Figure 125 is the method employed in another residence.

The safe-waste box is illustrated in the engraving. These are placed on the partition-walls of the basement—generally in the hall, but sometimes in storage closets—near the ceiling. At *a* is a ground coupling-valve to prevent odors from the basement rising to the rooms from which the pipes come when there is no water in the trap. There is a separate pipe from every safe, though several pipes sometimes come to one box, and the origin of each is marked on a plate on the

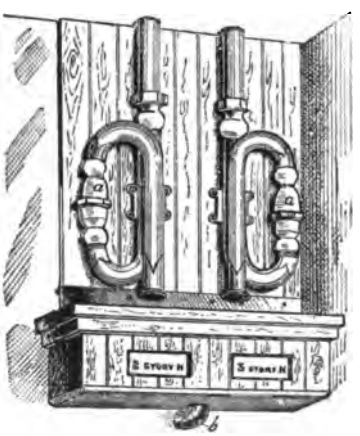


FIGURE 125.

box below it. From the box the waste, should there ever be more than enough to fill the trap, would escape through *b*, a pipe running down through the floor to the broken stone underlying the concrete foundation, and is provided in connection with the underdrainage.

SLABS FOR PANTRY-SINKS—WOOD VERSUS MARBLE.

Q. INFORMATION on the below-mentioned points is very much desired and will be thankfully appreciated. A client wishes, in alter-

ing a butler's pantry, to have the marble slab removed and wood substituted, because, as she says, the servants break the china. Reasons *pro* and *con* are wished. The client also wishes to have the butler's sink removed. In refitting, no means for washing the soiled dishes in a *permanent* sink are wanted (a movable pan will be used), but simply the faucets for water and an opening into the waste for emptying the pan and also, say, a pail of water; the idea being to prevent servants from washing the utensils in a permanent sink, it being difficult to keep same grease-clean. Can you suggest some appliance covering the requirements as to waste?

In the kitchen, the odors of cooking permeate the house, regardless of several closed doors. A hood over the range, leading to the kitchen-flue above, was suggested, but it was thought the draught of fire below would be affected. Is there any means of quickly and effectively leading away cooking fumes in a city-house kitchen, having range as ordinarily arranged?

If the reasons for using *wood* around butler's sink are predominant, is anything else required, besides oiling and Wheeler's filler, to prevent water and grease soaking into the wood surface?

A. Marble slabs are often complained of as borders for butler's sinks, on the ground of breakage of china. Some people use wood for borders, though it is more difficult to keep clean. If only a slop sink is wanted, in which the dish-tub can be emptied, it is best to make it of earthenware, which is easily kept clean. The ordinary white-glazed ware is made in several forms suitable for the purpose. Of course, a ventilated trap must be applied at the waste, not a bell-trap at the strainer.

Planished or tinned copper is often used for butler's sinks, with wooden border or shelf. The tin soon wears off, leaving the copper bare, and the wood border is subject to warping and cracking, from its frequent soaking in warm water spattered upon it, and is, therefore, objected to as difficult to keep clean. In Philadelphia, pantry-sinks made of wood and lined with sheet German silver are used; they, of course, retain their color when worn, as they are of one metal.

To remove smells from the kitchen, a hood is desirable, but it should connect with *an independent flue* in the kitchen-chimney, but not with the smoke-flue, as the draught would be affected, as you suggest.

FITTING BASINS TO MARBLE SLABS.

Q. WILL you explain the usual method adopted in New York to fit a basin to marble slabs?

A. The practice in New York, and I believe in many parts of this country, is to fasten the bowl to the slab by what are called basin-clamps. (See Figure 126.)

Figure 127 shows the underside of the slab, which contains three holes, into which the heads of the screws are inserted and molten lead poured in, which, on cooling, holds the bolt firmly, as will be seen by noticing the shape of the hole in Figure 128.

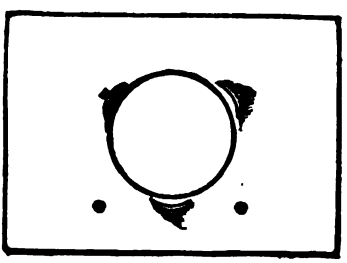


FIGURE 127.

The edges of the bowl are held tightly to the slab by screwing up the nut, so that the clamp is held securely in its place. I should mention here that the edges of the earthenware basins are not perfectly true and level, and in all properly-executed work these edges should be rubbed down smooth and even. The bowls are then set in plaster of Paris, which is mixed to about the consistency of molasses, and poured around the underside of the slab, adhering about the portion against which the edges of the basin are to rest. When properly done this makes a neat and water-tight joint.

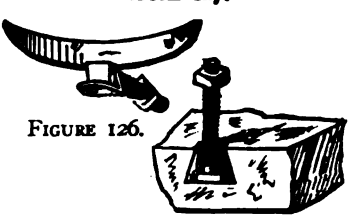


FIGURE 126.

FIGURE 128.

STAINS ON MARBLE.

Q. I OFTEN hear plumbers speak of finding stains on marble wash-stands or toilet-stands which they cannot remove or give a suitable explanation for. I have been told the cause in some instances is from ladies using a certain kind of perfumed tooth-powder which contains quinine, but I am not chemist enough to say if such a compound would create a permanent stain. Please suggest a remedy.

A. Marble, especially that which is called statuary marble, is porous and absorbent, consequently it retains any moist foreign matter which comes in contact with it, and stains are easily seen. The best Italian marble is less likely to show stains than the white, and is much better for plumbing purposes.

REMOVING RUST AND GREASE FROM MARBLE.

RUST spots on marble are caused, as a rule, when articles made of iron are laid on the marble when it is wet, or allowed to remain there when the atmosphere is in a humid condition. These spots penetrate somewhat deeply, as marble is very pourous, and can be effaced only by rubbing the marble sufficiently deep to remove the spots, and then repolishing the surface. As even the weakest acids will destroy marble such radical treatment cannot be entertained, or oxalic acid would immediately suggest itself as the correct remedy.

Grease spots from whatever cause, or the marks made by touching with soiled hands, can be removed by applying to the surface a stout paste made of equal parts of slacked lime and white pipe clay mixed with water, or calcined magnesia and white pipe clay will do equally as well. The paste must be applied in a thick layer all over the affected surface, and there permitted to remain for a couple of days, during which time it must be frequently moistened with water, and only allowed to dry after the full two days are passed, when it can be easily removed by rubbing with a soft cloth. Then the surface should be polished with the finest bolted whiting, and a piece of soft leather. This treatment cannot be applied to imitation marbles.

HOW TO DEAL WITH POLLUTION OF CELLAR-FLOORS.

Q. DURING the winter the water-pipes and the soil-pipe in my house in Brooklyn burst, and after some days we accidentally discovered that water-closet filth had leaked down and saturated a large place in the cellar-bottom, which is simply the natural soil, not cemented, nor even floored over. Now that warm weather is coming on, I am afraid of consequences and think of moving out. I have taken dry, clean earth and spread over the saturated place, and that has seemed to purify the air. Is there anything else to be done?

Are there any disinfecting substances which can be tried with success, or must the cellar be dug out? I may say that the landlord of this house will do nothing if not compelled to. It was only when the plumber whom he hired refused to patch up the pipe and insisted on putting in a new one that he would have it done.

A. The foul earth should be removed and replaced with new.

IS A CEMENT FLOOR IMPERVIOUS TO AIR?

Q. WILL a cement floor for a cellar allow ground-air to pass through it, bringing in contagion in case the soil is polluted, as it must be in Baltimore, judging from a recent letter in your paper?

A. Ordinary hydraulic cement, as commonly applied upon cellar-floors, has too much sand mixed with it to stop the passage of air. In fact, it is difficult to make a cellar-floor air-tight without an application of asphaltum, or other similar substance, applied hot.

DEPTH OF FOUNDATIONS TO PREVENT DAMPNESS OF SITE.

Q. How deep below foundations should drains be laid around a building to prevent dampness of site?

A. At least two feet below the foundation-walls.

HOW TO BURNISH WIPED-JOINTS.

Q. I HAVE just finished the fitting-up of a double boiler, and while I work with fine metal and am particular, the owner recommends burnishing the joints. Can you give me any information how to do it? He wants them to look like silver.

A. You may burnish a joint with any smooth and round steel burnisher, first carefully removing any roughness with a rasp and file. If you succeed in getting a smooth, bright surface, which is exceedingly difficult on such soft metal, you may then coat it with white varnish to prevent tarnishing. On the whole, we do not think it will

improve the appearance of your work, while it may convey the impression the plumber was not capable of wiping a good joint, and that he trimmed it into shape.

CONNECTING 45-DEGREE ELLS.

Q. WILL you kindly give us a rule for laying out work with 45-degree elbows?

A. We suppose our correspondent desires a rule for determining the length of the piece of pipe for connecting two 45-degree ells. The general opinion is that the easiest way is to multiply the distance which a line is to be offset by 1.414. This is accurate for any distance and any purpose for which pipe is fitted, and may be relied upon to find the distance from center to center of 45-degree fittings. Pipe fitters usually know how much to allow for fittings, and the offset piece may be cut without having the fittings in place to measure by. It is only necessary to deduct from the length found by using the decimal twice the distance from the center of the fitting to the point where the end of the pipe would reach when screwed into the fitting. There is another rule more easily handled by the generality of fitters. It is to add 5-12 for every inch which the line is to be offset to the distance of the offset. If the offset is as much as 1 foot or more, 5 inches for every foot in the offset in the line and 5-12 for every odd inch more than even feet is added to the distance of the offset. This rule gives nearly the same results as multiplying the offset by 1.414, and is easily applied mentally, hence its popularity. This latter method is not so accurate, however, and on big offsets it is not safe to trust to it entirely. One point in favor of its use is that the majority of offsets are less than 3 feet, on which it is close enough for all practical purposes.

HOW TO MAKE RUST-JOINTS.

Q. PLEASE explain the best method of making rust-joints. Are they as good as lead joints?

A. They are sometimes used for joints in iron pipe, but are not so certain to be tight as well-calked lead. The best method of mak-

ing such joints is to mix iron filings and a little sal-ammoniac, wet, and ram them into a joint over a gasket before it has been mixed long enough to rust the filings. The process of rusting expands the iron, and may, perhaps, make the joint tight if carefully mixed and filled—not otherwise. Too much sal-ammoniac will cause heat and enough expansion to split the hubs.

FREEZING A SERVICE PIPE.

Q. I HAVE some work to do on a system where there are no means of shutting off the water supplied to a building, and would like to know if it is safe to stop the water by freezing the service pipe.

A. If the service pipe is made of lead there is very little danger of bursting the pipe by freezing it when there is a chance for the water in the pipe to expand in both directions from the point where it is frozen. The work of freezing the pipe is comparatively simple, as are also the appliances that will be needed for doing it. The pipe can be frozen in from half an hour to an hour, depending upon its size and whether or not the water is running at the time freezing is attempted. If it is an ordinary pipe of ½ to ¾ inch diameter there will be very little difficulty. To freeze the pipe it is necessary to surround it with a mixture of ice and salt, and a simple and good way to keep this material in contact with this pipe would be to secure a small box of about 16 inches in length, 12 or 14 inches in width and about 12 inches deep. Saw notches in each end of the box about one-half of the depth of the box, and of sufficient width to slip over the pipe. The box should then be moistened with water and made water tight by being daubed with clay. The box should be placed in position around the pipe and firmly supported. The notches should be made water tight with the clay. Then by breaking the ice into quite small pieces, smaller than chestnut coal, and mixing with it a liberal sprinkling of coarse salt, such as is used in manufacturing ice cream, and filling the box with this, the freezing is only a question of time. It is a simple matter to tell when the pipe is sufficiently frozen to work by driving a small nail into the pipe to see if water comes out. If it still leaks water, the opening should be closed and more time given for the freezing mixture to act.

THAWING CONDUCTOR PIPES.

A SUCCESSFUL and cheap method of thawing conductor pipes is shown in the accompanying diagram. Figure 129 shows a building with the eave trough and conductor pipe with a 1¼-inch wrought iron pipe placed inside of the conductor for this purpose. This iron pipe is arranged so that no water can get on the inside of it. This is accomplished by letting the top end of the iron pipe extend above the eave trough and then covering it by means of a hood. It is raised to

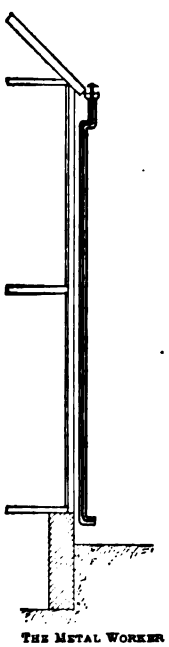


FIGURE 129.
System Arranged for Use.

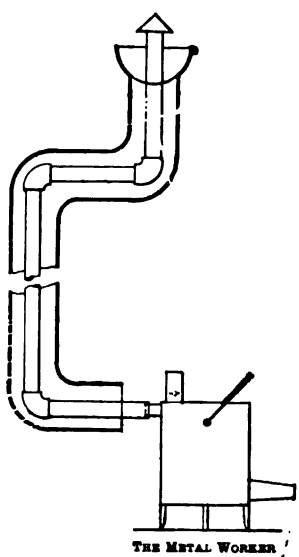


FIGURE 130.
Enlarged View Showing Heater.

sufficient height to prevent the water from the roof overflowing it. This method has been used successfully by making a small 8 x 8 inch sheet iron fire pot with a 1¼-inch flue to fit on the bottom end of a 1¼-inch pipe and connected with it as shown in Figure 130. The heat generated in the fire pot circulates through the 1¼-inch pipe, and there is no difficulty in thawing out the ice, however thick

it may have become. If it is to be used generally it would be better to use a larger conductor pipe, otherwise the water carrying capacity is considerably reduced.

ABSORPTION OF LIGHT BY GAS-GLOBES.

Q. I READ an article in regard to the different globes for gas-fixtures and their loss of diffusion, and it stated as follows: A plain glass globe they say loses 12 per cent., a ground glass globe 40 per cent., and an opal porcelain glass globe 60 per cent. Please tell me if you think this is correct. The reason I ask for this explanation is, that I took four ground globes out of a parlor; the cause of so doing was, they did not give enough light, and I substituted four opal globes, and two of these lighted gives more light than the three of the ground globes, and the workings of the opal globes do not conform with opaque rules. Please tell me your opinion of the matter.

A. The amount of light absorbed by glass globes varies somewhat according to the nature of the glass. A plain glass globe absorbs from 10 to 15 per cent.; ground glass from 25 to 40 per cent., and opal, from 35 to 60 per cent. Determinations recently made with the globes now in common use, having large openings at the bottom and top, show that 26 per cent. of the light is absorbed by ground glass, and 55 per cent. by opal glass. One advantage of globes with large openings at the bottom is that some of the light escapes into the room through the opening, and if these globes were substituted for the old-fashioned ones with small openings, considerable would be gained. Aside from this, globes having small openings cause a flickering and smoky flame, by producing strong currents of air through the globe.

A BY-PASS.

Q. PLEASE illustrate and explain a by-pass such as is used and referred to in plumbing practice.

A. Figure 131 shows a by-pass such as is commonly referred to and used in steam, gas and water service pipes. It is virtually a branch from a main which again connects with the main, with stop cocks on the main between the two points of connection. Between

the two stop cocks is a supply from the main to some other fixture. A stop cock is also placed in the branch. By this means it is possible for the gas, water or steam to be supplied to points on the main beyond the stop cocks, which would otherwise be shut off from supply when the branch between the stop cocks on the main is shut off. In gas fitting a by-pass is often used to fill a large service pipe gradually in order to prevent a reduction in pressure on other branches from the main by opening a large cock which controls the supply to other points on the large branch main. If the stop cock on the main proper were opened, the rush of gas to fill the pipe has been found to materially reduce the pressure, sometimes with the effect of permitting some of the lights to go out. The by-pass is also used to supply the system independent of a pressure regulator that may be on the main. In water piping, particularly on large service pipes, the pressure on one side of a large gate valve is liable to be so high as to require a great power to open the valve; but by using a by-pass to supply the water to the pipe on the other side of the valve the pressure is equalized, and the power required to open the gate valve is very much reduced and the valve relieved of a severe strain.

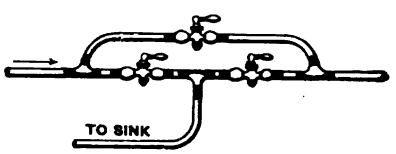


FIGURE 131.
An Ordinary By-Pass.

In steam heating, the by-pass is frequently used where the boiler carries a high pressure and a low pressure is needed for heating purposes; the system being so piped, however, that when necessary a high pressure of steam can be carried on the heating system, but under general conditions the pressure is reduced to about 5 pounds by means of a pressure-reducing valve placed in the by-pass. In water service, a water motor or water meter is frequently placed on the main, and a by-pass is provided to supply the building with water in case either of these fixtures becomes out of order and unfit for use. Figure 132 shows a by-pass which was suggested by a correspondent, with the assumption that the sink would be supplied

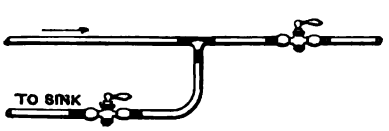


FIGURE 132.
A Suggested By-Pass.

with water when the main was shut off; but from the description already given it can be seen that this is not a by-pass, but a branch from the main before the stop cock is reached. It has been suggested by another correspondent that the word by-pass seems to belong exclusively to American plumbing literature; and in his opinion, as applied to American plumbing practice, it means a blunder in arranging the vent pipe in the drainage system, by means of which sewer gas is allowed to pass around the trap and into the building. The local vents from water-closets or urinals are sometimes connected into the same pipe which vents the trap used in connection with the fixture, and by this means, as shown in Figure 133, the by-pass around the water seal of the trap is made into the room from which it is desirable to exclude the sewer gas. Figure 134 shows another arrangement of vent pipes to waste pipes in connection with bathtub and lavatory, by means of which the odors from the drainage system may pass up from the vent pipe to the bathtub trap and down through the vent pipe to the lavatory trap, and from that point over to the waste pipe of the bathtub and through this opening into the bathroom. If the lavatory waste is connected with the trap from the bathtub, it should be by all means below the water line of the seal of the trap; but the better means is to connect it with the waste pipe from the bathtub after having passed the bathtub trap.

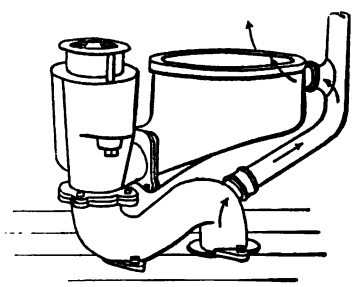


FIGURE 133.
A Water-Closet By-Pass.

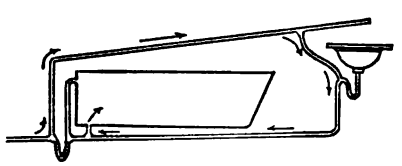


FIGURE 134.
By-Pass Between Sink and Lavatory.

AN AIR LOCK.

Q. PLEASE explain what is meant by an air lock and what is the result of an air lock between two fixtures?

A. We suppose our correspondent means by air lock what is ordinarily known as air bound. This condition is usually found when there are two or more dips in a pipe, which permit air to collect in the high portion of the pipe and water in the lower portions. When such a condition exists a very effectual obstruction is met, which interferes seriously with the flow of water through the pipe. An accumulation of air under the circumstances described has been sufficient to stop the flow of water from a point several feet above the point of stoppage. Several years ago an air lock in a 12-inch water main in a city along the Hudson River was the cause of reducing the flow of water through the main more than half, and was removed by digging down to the pipe at the high point, tapping it, and connecting a pipe with it and running up near the surface of the ground, where a stop cock was placed so that any accumulation of air could be allowed to escape. An air-bound waste pipe has been found in a number of cases to prevent the discharge of water from a fixture, even when the fixture was located several feet above the pipe. No little trouble has been found in hot water heating systems and in steam heating systems also where either a dip or raise in the pipe has permitted an accumulation of air; and the only remedy has been to tap the pipe and arrange it so that the air would flow to some point where there was an aircock.

WHY LEAD PIPE WAS DESTROYED.

Q. WE send you a small piece of lead pipe that was put in the ground 3 feet from the surface four years ago. This pipe was buried in a filling composed of coal ashes and coal cinders, and was put in to replace a galvanized-iron pipe that had been eaten through in a year by the action of chemicals evolving from the cinder pile, which, according to our understanding was either sulphurous or sulphuric acid, and which lead pipe is supposed to withstand. We are, therefore, nonplussed to find this lead pipe literally eaten up wherever it goes inside the lot running to the house. But the most singular part of it is that outside the fence, along the street, where there is a filling composed entirely of cinders, the lead pipe main, of which this is a branch, is perfectly sound and good, and it does not show any erosion whatever, while the one from which this is taken is eaten up and full of holes. What combination of acids or alkalies would have this effect on lead pipe is what we would like to know. For your information we would further state that this pipe goes to supply a boarding house, and it may be possible that

the chambermaids have for years been throwing slops over the ground. The solution may be in the fact that some of these slops containing urine, in combination with the sulphuric acid, which is undoubtedly in the cinders and ashes, has caused it.

A. The chemicals acting upon the lead pipe appear to be acetic acid and carbonic acid gas, both of which will combine with the lead, forming what is known as white lead. The acetic acid or other vegetable acids will attack the lead, and the carbonic acid generated by the fermentation of the garbage will finish the destruction of the lead or any other pipe ordinarily used for service pipe. To preserve the pipe cover it with asphalt applied hot or with hydraulic cement thick enough to keep the pipe free from seepage water.

PLUMBER'S TOOL CHEST.

EVERY good mechanic takes an interest in the tools he works with, especially if he has become familiar with them by long usage.

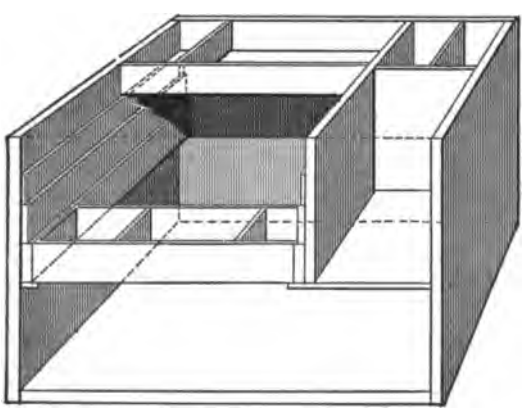


FIGURE 135.
Interior Arrangement

Their little peculiarities get in touch with the workman so much that he can do a better job with them than with others, and that a man should take a certain amount of pride in keeping them in good order is commendable. A good tool chest is indispensable. A plumber's bag is all right as far as it goes, but it does not go far enough, and

when one is working on new buildings that may not be far enough advanced to be locked up for the night, the tools may be put away in their places, the chest locked, and you depart without any misgivings as to whether some of your tools may be missing in the morning.

The following description shows a method of making a plumber's tool chest. Figure 135 shows a perspective view, with the front removed, of a chest 36 x 24 x 22 inches deep. Ten inches from one end is a partition extending the whole width of the box, about 9 inches from the bottom, to carry the ends of the drawers, which slide back and forth upon the runners, shown in the section, each of which projects ⅜ inch past the other, so that each set of drawers will be about ¾ inch shorter than the one immediately above it. They should be made to slide freely, but not too loosely, or they will stick and cause trouble, and about 8 inches wide, two on each tier, or eight in all. They may be subdivided by small partitions, as shown, to suit individual requirements. In them may be found a place for many things, wiping cloths, bending irons, shave hooks, screw drivers, plumb bob, chalk line, tap borer, gas pliers, pipe wrenches, an assortment of bits, drift plugs, turn pins, tape measure, files, rasp, saw, bevel, cold chisels, etc. In the bottom of the chest there is provision for storing articles of greater weight and length, 1¼ x 1½ x 2-inch lead pipe benders, wooden mandrels the same size, stocks and dies, pipe cutters, calking tools, boxwood dressers, spirit level, large size pipe wrenches, dummies, etc. A compartment is reserved for the plumber's furnace and another for the gasoline torch, and a square can for a supply of gasoline. At the end of the chest, supported horizontally, are hatchet, bolts, ladles, etc.

FIGURE 136.
Section Showing Construction

As these chests must stand a good deal of rough usage they need to be made very strong. The one in question is constructed of 1-inch hard wood, dovetailed at corners, with base 4 inches wide and a similar piece near the top, which forms a rest for the cover,

all of which is shown in section in Figure 136. Two hinges and a strong hasp are fastened on securely with tire bolts, which are riveted a little to prevent any possibility of the nuts coming loose. The corners are strengthened by iron plates, and two strong handles complete its construction.

A PLUMBER'S REASONABLE PROFIT.

THE merchant or banker whose annual transactions are by the million naturally looks upon a gross profit of 30 or 40 per cent. on the part of a plumber as something monstrous, yet on a moment's reflection any fair-minded man will admit that the margin of profit should be governed entirely by the nature of the business, the amount possible to do safely in a year, and the proportion of expense in doing the business to the amount done. To illustrate: In this city there are about nine hundred so-called plumbers, besides a large number of idle journeymen ready to take any job that offers. The average amount of business done by each firm is not over $10,000 annually, including contract work for builders, jobbing, and days' work. As a rule, contract work pays little or no profit to men who do the work properly and pay for the labor and materials, and it is only taken by good parties to keep extra journeymen employed. Allowing a man to do an annual business of even $20,000, what gross profit should he require to pay his business expenses and have left a living and something to lay by for a rainy day? for every man hopes to make something besides shelter, food and clothing.

EXPENSES AND LOSSES.

Rent of store, which must be in location accessible to customers who live in best parts of the city	$1,000
Book-keeper and clerk to attend store while proprietor is giving personal attention to work	800
Interest on capital, and sundry expenses doing business, collector, etc.	500
Keep of horse, wagon, and boy for driver	500
Bad debts in jobbing business, not counting possible losses through working for speculating builders	500
	$3,300

If these figures are correct, and we believe they are, we contend that 30 per cent, average gross profit is not exorbitant, but entirely legitimate. Merchants know that different articles pay vary-

ing degrees of profit, and as certain materials used by the plumber are limited to 5 and 10 per cent. margins, others must pay more to make up the average. For instance, the proportion between the different rates of profit may be thus represented in tabular form:

$5,000 @ 10%	$500
6,000 @ 25%	1,500
5,000 @ 40%	2,000
4,000 @ 50%	2,000
Yielding gross profit	$6,000
Deduct expenses	3,300
Net profit	$2,700

Few plumbers in this city make $2,700 net annually, notwithstanding the hue and cry made about exorbitant profits, and where it has been made we contend it is not too much, considering the hazards of business, for a man to make, who has the intelligence and capability that would render it safe to employ him to attend to such important matters as house-plumbing. It is, however, too much to pay ignorant men to do imperfect work, and the public should not employ the latter class and thus curtail the business of the former, making it necessary to obtain an even greater margin on a smaller business.

In this article it is not proposed to insist that any one should pay these profits, but only to show that what in some branches of trade might be exorbitant is in this business only reasonable, legitimate, and necessary, even considering the matter simply from a mercantile standpoint.

BOILERS, WATER-BACKS AND HOT WATER SERVICE PIPING

BATH BOILERS.

WITH the average working plumber there is no feature of his trade of such interest as the fitting up of a hot-water boiler, under the varying conditions of water-supply in the United States and the demands for domestic consumption of hot water, the latter being much greater in this country than elsewhere.

So little is understood of the theory of hot-water circulation by many who essay to arrange the apparatus for it, that we must attribute to that fact the greater portion of the defects complained of by householders generally.

It is not the purpose to dwell on the physics of the subject, but to briefly allude to some of the various means employed abroad to secure hot water for domestic purposes, and compare them with the practice adopted in the leading cities in this country. Before illustrating the various hot-water apparatus, it may be of interest to some readers to have briefly pointed out the cause of the most common sources of complaint and the course to be pursued in dealing with the difficulty.

The treatment will be mainly confined to the cases of hot-water boilers supplied directly from the street mains, which is the custom in most cities in this country, and which is liable to more mishaps and casualties than when supplied from tanks.

One of the complaints the householder has to make is that of a rumbling or pounding noise in the boiler. The most common mishaps are the collapsing of a boiler or the bursting of a water-back in the winter time after the range fire has been rebuilt, and when the water in the water-back or connecting pipes is frozen.

The rumbling or pounding noise, most heard on ironing days, when a hot fire is kept in the range, and not much hot water is used, is occasioned by steam being generated in the water-back, which, when it meets with water cold enough to condense it, produces a vacuum. The water coming together again to fill this void space causes the concussion, which makes this noise. The generation of

steam is also often due to the fact that the water-back has too much heating-surface for the capacity of the boiler and the domestic requirements for hot water.

To stop this noise and get rid of the steam, it is the custom to open the hot-water faucet. This will accomplish it; but if the hot-water faucet is opened suddenly there is danger of the boiler collapsing if it be a copper one, for the reason that the cold water, suddenly returning to fill the space occupied by the steam, condenses the steam instantly and produces the vacuum, which results in the collapse of the boiler. It is safer to open the hot-water faucet very slowly and thus prevent the sudden condensation of the steam. The risk of collapse is also greater in a city where the water-pressure is very light, as in New York, for the steam meets with so little resistance, by reason of want of pressure, that it more readily forms and more easily forces the water out of the boiler and through the pipes back to the street-main.

The other danger alluded to, and one that in winter has been occasionally experienced, is the bursting of the water-back, and the consequent demolition of the range. This is solely due to ignorance or carelessness. If a range fire is let down on a cold night, and the water in the water-back or in the connecting-pipes between it and the boiler becomes frozen, so that circulation is impeded, the building of a fire in the range under such circumstances is almost certain to cause an explosion, which might prove fatal to life as well as disastrous to property, for it is manifest that as soon as the water-back becomes heated the water expands or steam is generated, and if it is confined, and not permitted to circulate, something has to give way, and an explosion is the result. The same thing might occur if both the hot and cold water pipes become frozen. Householders should therefore see to it that during cold weather a fire is kept in the range, so that the freezing up might not occur. If for any reason it is necessary to let the fire out for any period, care should be taken to empty the boiler, to uncouple it from the water-back, and to *blow out all the water that may be in the water-back*, using a plumber's force-pump for the purpose.

Explosions have been known to occur because so-called plumbers have disconnected the boiler for repairs and forgotten to blow the water out of the water-back, which afterward became frozen, and then, when connecting it again, neglected to ascertain whether the means of circulation were impeded or not.

In considering the various styles of hot-water bath-boilers in use, those are shown first that are most frequently seen on the Continent of Europe. That shown in Figure 137 consists of a cylinder set over a gas-stove. This reservoir holds about enough hot water for one bath. The cold-water supply from the cistern is connected to it, while another pipe conveys the heated water from it to the faucet over the bathtub. The gas is lit under this reservoir when a person desires to bathe, and in a few minutes the water is sufficiently heated to satisfy the wants of people who have no conception of a more expeditious method.

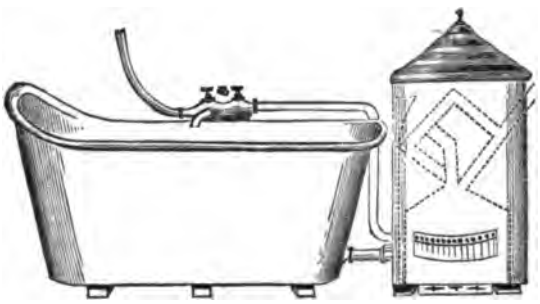


FIGURE 137.

Figure 138 (which is reproduced from Buchan's "Plumbing") shows a plan formerly in vogue in Great Britain, which, as will be seen, consists of two tanks communicating with each other. X is the cold-water cistern and W is the hot-water cistern. The water reaches the latter through the pipe Y, on which is a light copper flap, which can be lifted by the pressure of the incoming cold water, but which prevents the return of the hot water. Z is the cold-water pipe to the boiler A, while B is the pipe that takes the heated water from A to the hot cistern W. In the sketch this cistern has a cover, with the pipe H, to permit the escape of steam. When they are not covered the steam is an annoyance in the room in which they are placed, and the tanks

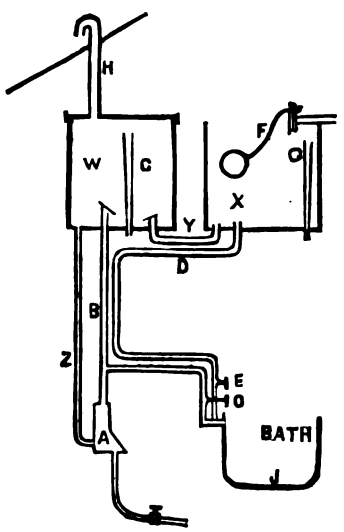


FIGURE 138.

soon collect dirt, and require frequent cleaning out. It will be noticed that what is here called a boiler (A) is substantially like what we call a water-back.

Of late years the fitting up of hot water apparatus in England has been gone into more elaborately, and seems to be a compromise between our water-back and the back-log boilers. Figures 139 and 140 show two forms of boilers. The latter is termed a "saddle-boiler," and is made the shape of the arch of a stove front, and is fixed in the stove as shown in Figure 141. The dome-top bath-boiler shown in Figure 139 is set in brick-work, as shown in Figure 142. It will be seen that this requires a separate fire, which with us is avoided, as the ordinary kitchen-range performs the duty of heating a limited amount of water for domestic purposes, in addition to its other functions.

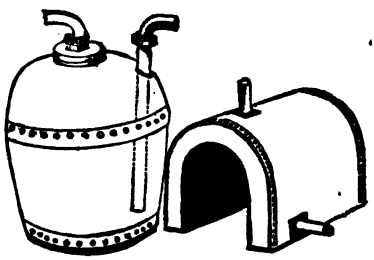


FIGURE 139. FIGURE 140.

The English papers state that the bursting of hot-water boilers, as they are there called, has been very frequent in the winter, and in several cases has been attended with very serious results. This has doubtless called out the circular issued by the Manchester Steam Users' Association, in which some good suggestions are made to householders.

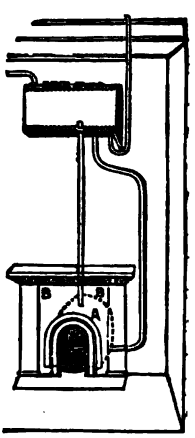


FIGURE 141.

In the newspaper accounts of these casualties they always speak of the "boiler bursting," but this is what we call a water-back. The unusual number of these occurrences is doubtless due to the very cold weather and the want of proper provision to prevent the freezing of the hot and cold water pipes which might be expected in a country where such extreme cold was an uncommon thing. To this fact and to the ignorance of servants in building a fire in a range before it was certain that there was no impediment to the circulation of water in the pipes, must be attributed these disasters, and in reading of them it is plain to be seen that the ignorant plumbers and householders are not all on this side of the Atlantic.

Figure 143, which is copied from an English catalogue, shows a more complete arrangement than those illustrated before. In this there is a range to do the duty of heating the water. B is the boiler or water-back; C the hot cistern, which in this case is tightly closed. It is made usually of galvanized wrought-iron, and really answers the same purpose that our boilers do which we place alongside our ranges. D is the cold-water pipe from the hot cistern to the boiler or water-back; E, the return or hot-water pipe to the hot cistern, and F is the cold-water tank, G is the pipe to convey cold water from the tank to the hot cistern; I is the pipe to convey hot water to the bath-tub; K is a relief-pipe from the hot cistern to above and over the cold water tank.

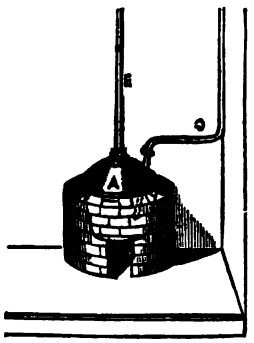


FIGURE 142.

The place selected for locating the hot cisterns depends on circumstances; it is usually placed above the points where it is proposed to draw hot water, but it is sometimes put in the bath-room at the end of the bath-tub, with a warming-closet or linen-warmer placed just above it, so that it can secure some of its waste heat for the purpose of warming towels, etc..

J. W. Hughes, of Montreal, says: "I give a short sketch on the prevailing method of fitting hot-water attachments for bath and other purposes here, as it may be of interest to my American colaborers at the plumbing trade. Boilers, or, as you call them, copper reservoirs, are the exception; and the cistern plan

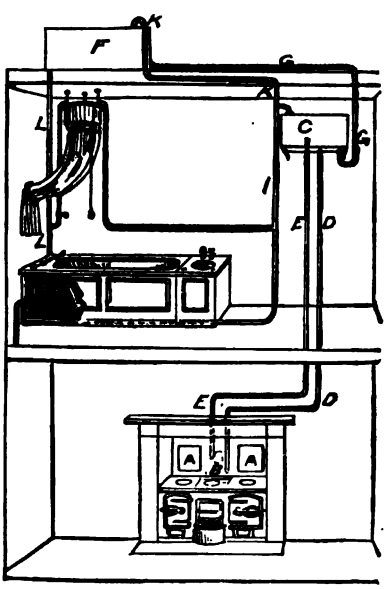


FIGURE 143.

is the rule, although I have fitted up several houses on the American plan.

"The greatest objection to the cistern plan is, that they are usually set immediately over the closet (pan water-closets generally used here), and as they are fed from the cistern supplying the water-closet, said cistern being uncovered, they are not at all right in a sanitary point of view, especially when, as is frequently the case, careless servants take hot water from the taps for cooking purposes.

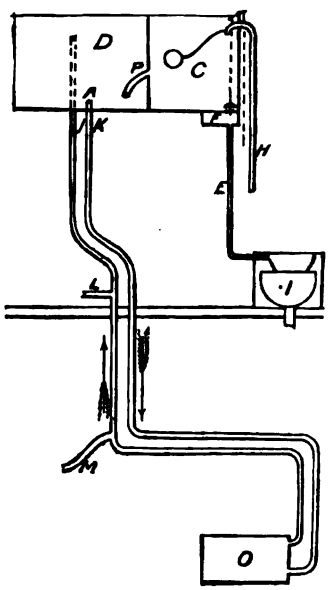


FIGURE 144.

"In Figure 144, A is the hot-water compartment, usually lined with 5-pound lead or light copper; B, the division between hot and cold cisterns; C, the cold cistern supplying the water-closet, and also hot-water cistern through pipe P, which is joined about the centre of division, the end in hot-water cistern being turned down to within one inch of bottom. A galvanized-iron cover is fitted tight on the hot-water cistern; E is the ball-cock on city service for cold water; F, service-box; G, service-pipe; H, cold-water supply-pipe; I, water-closet; J, hot-water circulating-pipe, standing up about eight inches from bottom of cistern and carried direct to ceiling over range or stove, to which it is connected from top outlet of heater by an iron pipe. From this pipe, J, are taken branches L M N, to supply hot water to bath, basin-sink, etc. K is the cold-water circulation taken direct from bottom of the cistern and joined to the heater, as shown. O is the heater in the range; the arrows show the direction of circulation-pipes J K, generally $\frac{5}{8}$" 6-pound to the yard lead pipe. A good supply of hot water is obtained by this method.

"The sketch shows front of cistern removed; if the water boils or steam is made in large quantities, a 2-inch galvanized ventilator is run from the cover D."

Having described the various methods of fitting up hot-water boilers in England, and also given a description of a plan in vogue in Canada, reference to the various methods adopted in the United States will now be made, commencing with the "back-log boiler," which has been extensively used in Philadelphia and in other portions of Pennsylvania. It takes its name because, like the large log in the old-fashioned fire-place, it lies across the chimney-breast, behind the ovens, and across the flues.

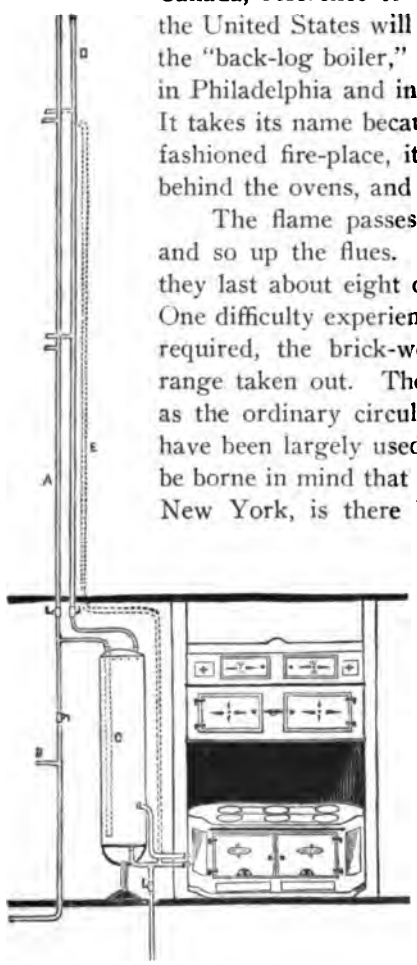


FIGURE 145.

The flame passes under and back of the boiler, and so up the flues. They are generally bricked in; they last about eight or ten years before burning out. One difficulty experienced is that when any repairs are required, the brick-work must be removed and the range taken out. They do not heat water as rapidly as the ordinary circulating-boiler, but, being cheaper, have been largely used in the city referred to. It will be borne in mind that the tenement-house, as known in New York, is there but little known, so that every mechanic can have his house; and even in these humble dwellings they have their bath-tub, and bath-boiler to make hot water.

These back-log boilers are made of wrought-iron, the same shape as our circulating-boilers, with cast-iron heads and bottoms. They are usually not galvanized. They have two couplings on one end, one for the cold water to enter and the other for the hot water to pass out.

The ordinary wrought-iron circulating-boilers were first made and brought into general use also in Philadelphia, it has been claimed. They have very largely superseded the copper boilers, mainly because in most cities the boiler is supplied from the main direct, and not from a tank. This, as will be seen, subjects them to whatever pressure the water exerts, which in many cases is quite heavy. Take,

old houses they have been placed on a soapstone slab with a brick foundation, on one side of which is an iron door. Inside of this latter is the sediment-cock to empty the boiler. It will be noticed that it has been advised that fixtures upstairs should take the cold-water supply from the down pipe D, and not from the cold-water main to the tank. In good work this rule is observed, but in cheap work, or where plumbers desire to save every foot of pipe possible, they often take the branch from the rising main when that pipe is a little nearer to the fixtures to be served. Much of the complaint about ball-cocks jumping or making a noise, faucets leaking, and water-hammer, are due to this fact, and architects in writing specifications should be careful to specify from which pipe the branches should be taken, and then see that the specifications in that particular are carried out. Of course it is to be understood that the cold-water faucet over the kitchen-sink and the pantry-sink, or wherever it is desired to draw water for cooking or drinking, should not be supplied from a branch from the main in the cellar, *independent of the pipe to the ball-cock at the tank,* unless the disturbance of this ball-cock, whenever a faucet is suddenly shut, is no objection or annoyance.

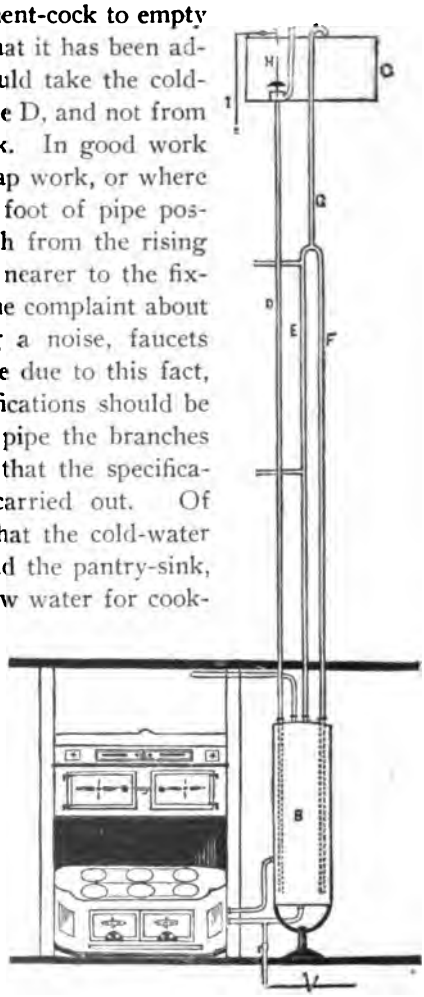


FIGURE 147.

The city water has not sufficient force to ascend to the upper floors of buildings in cities carrying a low pressure. It is, of course, desirable to be able to draw hot water on every floor. This, however, would, under such conditions, be impossible, as the hot water cannot go above the cold water that supplies the boiler.

To place a tank in the attic or fourth floor from which the boiler is to be supplied, as shown in Figure 148, would involve pumping

into that tank all the water that is afterward heated and used as hot water. The double-boiler system obviates this requirement, as it is only necessary to pump the water wanted for fixtures above where it will flow from the street-main. This water is supplied to the inside boiler which furnishes the hot water for the upper stories.

The double boiler, as shown in Figure 148, consists of two copper cylinders, the space between the inner shell and the outer one being of the same capacity as the inside of the inner boiler—that is to say, an 80-gallon double-boiler means that the inside and outside boiler will hold forty gallons each. By reference to the drawing it will be seen that the cold-water supply passes under the sink, with a stop-cock at B, up alongside of the boiler, with a check-valve H, which is placed there to prevent drawing water from the outer boiler when the pump is working or the water is shut off in the street. Just above this check-valve a branch from this cold-water supply-pipe is taken and connected to the cold-water supply to the inside boiler which comes from the tank. On this is also placed a check-valve that will prevent the cold water from the tank from running to the main, while, on the other hand, it will permit the water from the street-main to fill the inside boiler at any time that the tank should become empty. It will be noticed that the hot-water pipes from both inside and outside boilers extend over and above the tank, with their ends open to permit the escape of steam. The hot water required at points above where the cold water will rise is taken from branches out of the hot-water pipe from the inside boiler, while the hot water required below that point is taken from the pipe that comes from the outside boiler. The tank is filled by a pump, which is usually placed in the cellar, instead of alongside the kitchen-sink, as shown in the sketch. A circulating-pipe is run from the outside boiler hot-water pipe, but not from the inside one.

It sometimes happens that these boilers are so fitted up that when the water from the inside boiler is drawn off it has collapsed from the pressure of the water surrounding it, by reason of some one ignorantly or carelessly emptying the inside one before the outside.

The arrangement of the sediment-cocks as shown in the drawing would prevent such an occurrence, because if the stop-cock G was opened, the water could not be drawn from the inside boiler until A was also opened, which would simultaneously empty the outer boiler.

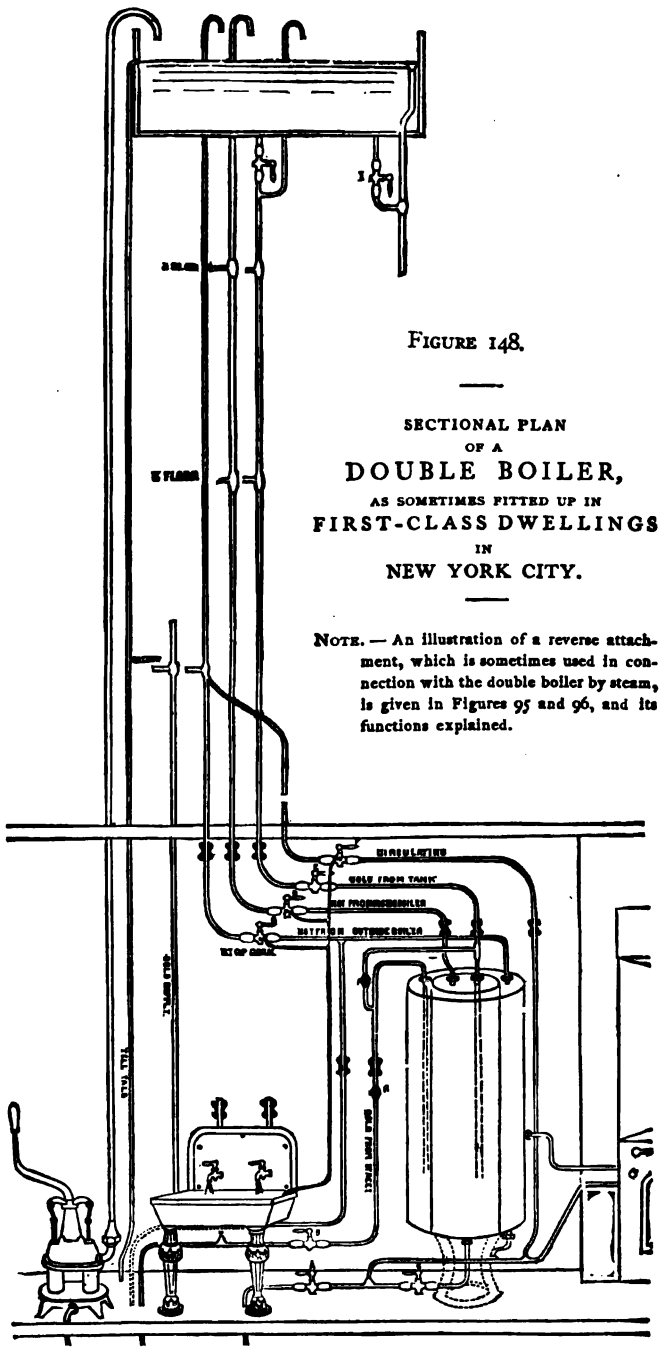


FIGURE 148.

SECTIONAL PLAN
OF A
DOUBLE BOILER,
AS SOMETIMES FITTED UP IN
FIRST-CLASS DWELLINGS
IN
NEW YORK CITY.

NOTE. — An illustration of a reverse attachment, which is sometimes used in connection with the double boiler by steam, is given in Figures 95 and 96, and its functions explained.

The outside boiler can be emptied without affecting the inner one, but not the reverse.

The reverse attachment alluded to in the note on Figure 148 is illustrated in Figure 149. In order that the following explanation may be more readily understood, it will be well to refer to the illustration of the double-boiler system shown in Figure 148. In most houses where this system is adopted, it is found that on the upper floor the flow of water from the street-main is intermittent—*i. e.*, at times water is not obtainable, by reason of an insufficient pressure in the street-mains; at other times the pressure is ample to supply that floor.

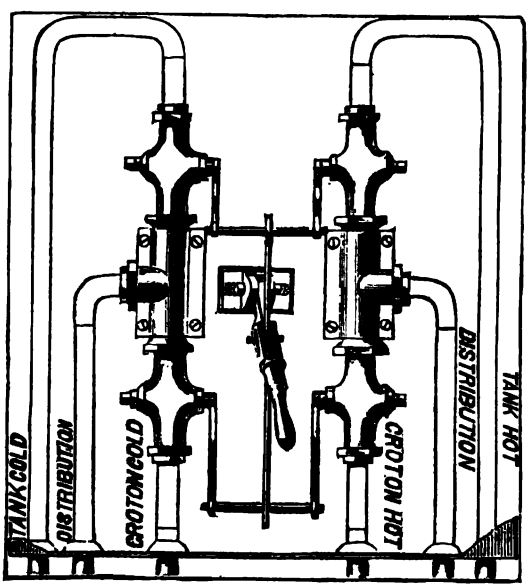


FIGURE 149.

In such situations, therefore, the reverse cock is placed on the branch-pipes from both the tank and street-main hot and cold water pipes. This is put under a wash-basin or in some accessible place, so that when the supply from the main fails, a supply from the tank can be obtained by a turn of the lever, which, when closing the two stop-cocks on the supply-pipe from the street, opens the stop-cocks on the hot and cold supply-pipes from the tank. Of course, when these are open the water used is that which has to be pumped; consequently they are only kept open when the street-pressure fails to reach that floor. By reference to the sketch, it will be noticed that the pipes all come through the lead safe, which indicates its location under a wash-basin; of course a plumber will understand the various ways that the branches can be run so that they come up through the safe as shown. It will also be

noticed that this reverse attachment is referred to as being placed on the branches. It is asserted that in some instances plumbers have connected one or more of the cocks in this attachment to the main pipes, either to save pipe or because it was a little more convenient. By an examination of the double-boiler cut it will be made evident that this would be a dangerous proceeding, because the closing of one of these cocks would close the expansion-pipe that extends from the boiler over the tank, with its end open to permit the escape of steam, and would result in straining the boiler, if not the more serious casualty of an explosion.

Figure 150 shows the usual arrangement before the reverse attachment was made, which, as will be seen, consists in placing separate stop-cocks on each branch from street and tank supply. This is also shown located under a wash-basin. It is customary to put a label on each stop-cock to indicate its particular use.

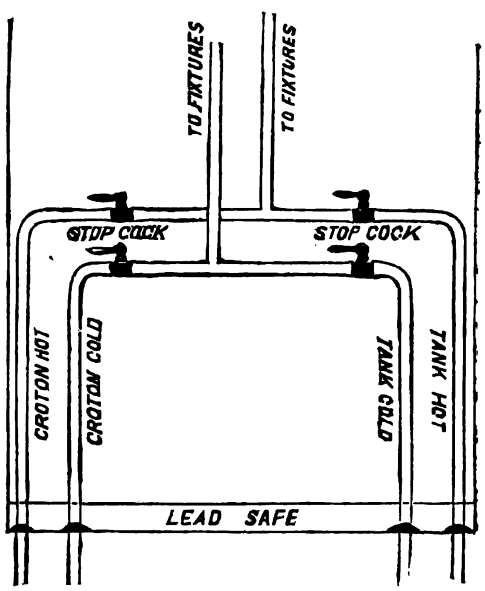


FIGURE 150

Occasionally two independent boilers are used in place of a double boiler, to secure the same results; but in most kitchens a convenient space to locate them cannot be found, although when such an arrangement is practicable, each boiler can be larger—that is to say, from 50 to 80 gallons each, which would be equivalent to an 120 to 160 gallon double boiler, whereas the sizes most frequently used are from 80 to 100 gallons capacity. As a general thing where double boilers are used, an independent single boiler of from 40 to 50 gallons capacity is provided for the laundry, and placed alongside the laundry range, and connected with its water-back. This is intended to supply hot water only for laundry purposes.

In the reference to hot-water boilers placed in the laundry of a private dwelling, mentioned above, a New York City custom is described.

In New York City, where the building of flats has become so general, the question is frequently raised whether it is better to have a bath-boiler for each flat in each kitchen, connected with the water-back in the range, or whether the hot water should be supplied to each flat from some central source—as, for instance, a large boiler in the basement. In intelligently deciding this point various things must be considered. In the smaller flats, where steam is not required to run elevators, and is only needed to heat the halls in the winter time, it is the practice, and is, no doubt, more economical for the owner of the building to provide a boiler for each flat, as the fuel required by the family for cooking will also heat what water is needed, and this, of course, involves no expense to the landlord. As usually fitted up in flats, copper boilers are apt to collapse, because of the liability of the water being siphoned out of those on the upper floors when it is drawn off at a lower point. This could be guarded against, but specifications do not require the precautions to be taken, and the cost would deter any plumber from doing it in contract work, consequently galvanized-iron boilers are now almost universally used in such situations, as they are sufficiently strong to withstand the atmospheric pressure in the event of there being a vacuum formed inside of them by the withdrawal of their contents. One other objection is the fact that the boiler in the small kitchen of a flat adds to the heat of this, as well as of the adjoining rooms, and in hot weather this is sometimes an inconvenience.

In hotels and first-class flats water is heated for use throughout the building by placing a coil of brass or iron pipe inside a large wrought-iron tank, and heating the water by passing steam through this coil. Brass pipe is considered for this purpose to make the best job; but iron is most frequently used, although copper mains—such as are used in stills—are sometimes adopted.

Exhaust steam is sometimes availed of for this purpose, and is the most economical. These hot-water tanks are supplied with water from the tank on the top floor; connections are also made to supply them from the street-main, with a check-valve on this pipe to prevent the tank-water from running back to the main, but to permit the street-pressure to supply the boiler when there is no water in the upper tank.

In these articles on hot-water boilers it seems proper to refer to the wearing out of hot-water pipes, which occurs with the most frequency near the range or between the boiler and the range. This is generally due, in the case of lead pipe, to impeded circulation or too much heating capacity in the water-back, there being considerable difference in this respect with the various makers of ranges. In some cases, where the water-back was large, a piece of wrought-iron pipe, this shape (⊃), is substituted for a large cast-iron water-back. This will burn out in time, but is capable of making a great deal of hot water. Where lead is used for the hot-water pipe, it has been the practice, in first-class work, to have a copper pipe brazed on to the coupling of the boiler and of the water-back, and in order that the coppersmith could get the exact dimensions and the proper direction for this connecting piece, a lead-pipe connection was made to serve as a model; and to insure an absolutely tight and strong joint where the pipe was brazed to the couplings, a good soldered joint was wiped over it. Connections made as here described have been found much more durable than with the ordinary lead pipe.

Vacuum-valves have been largely sold for use on the hot-water pipes of copper boilers, to supply air and prevent a collapse. Some are made to screw into a spud attached to the boiler for this especial purpose. They have never been considered reliable, and the experience of plumbers has been that the valve, not being in constant use, is liable to stick to its seat and become inoperative when most needed. An expansion-pipe, as before explained, with its open end above the source of the supply to the boiler, which should be a tank in the upper part of the house, is the safer plan.

SETTING HORIZONTAL BOILERS.

THOUGH information has been frequently sought and given as to the best way to run the circulating-pipes between a water-back and boiler; the proper position *in the boiler* for the pipe-connections does not seem to be understood, as may be judged from a boiler received from a large manufacturer, in which the couplings were so placed that only about one-half the capacity of the boiler would be available for use. The boiler was to rest horizontally—a position in which

many boilers are now set, and the Figures 151, 152, 153 show the pipe-connections.

D, inlet for cold water, with tube running into boiler; B, for hot water to pass out; A and C, upper and lower circulating connections.

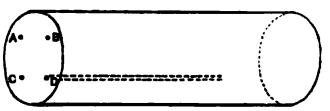


FIGURE 151.

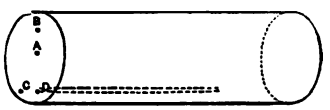


FIGURE 152.

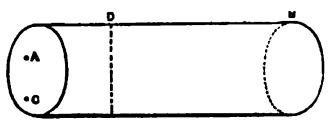


FIGURE 153.

A moment's thought will show that water below C *will not heat*, and that the water above B *cannot be drawn off*. The capacity of the boiler is therefore only that portion between the horizontal planes passing through C and B, Figure 151, or very little over one-half the whole boiler. The proper position for couplings to horizontal boilers is shown in Figures 152 and 153, in which D represents the cold in pipe; B the hot out pipe; A, upper circulation; C, lower circulation.

In a vertical boiler care, of course, must be taken to have the inside tube upon the *cold*-water supply to boiler, but in horizontal boilers care is not always taken to observe the following rules, applicable alike to vertical and horizontal boilers:

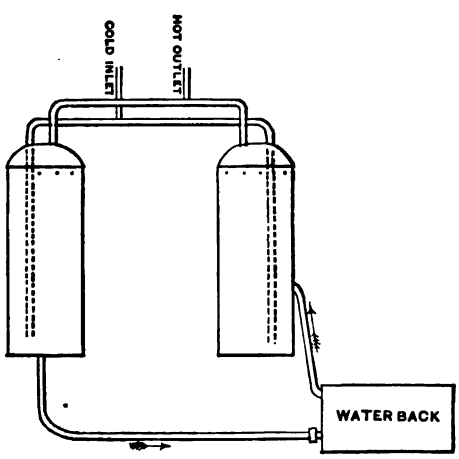


FIGURE 154.

First—Cold water should be delivered into the boiler at a point *near its bottom*. To prevent the boiler being emptied through this cold supply-pipe it is best to have the coupling near the top of boiler, and carry a pipe from it inside the boiler to near the bottom.

Second—The lower circulating-pipe should connect at or very near the bottom of the boiler, so that all the water in

the boiler may be heated. The position of the upper circulating coupling is not material.

Third—The outlet-pipe for hot water should be at the top of the boiler, so that *all* the hot water may be drawn off.

Fourth—The inlet and outlet pipes should not be too near together, lest the rapid flow, when hot water is drawn, establish a current between them, and so fail to draw the hot water from the boiler.

Where a boiler is too small and it is desired to add another boiler, instead of throwing out the old one and replacing it with a single large one, they can be coupled as shown in Figure 154. Both boilers heat alike, and are drawn off together.

HOW TO SECURE CIRCULATION BETWEEN BOILERS IN DIFFERENT HOUSES.

Q. I HAVE a customer that occupies two separate houses adjoining, as shown in sketch. House No. 1, kitchen is only used to do laundry-work in; the range is heated up about three days in a week.

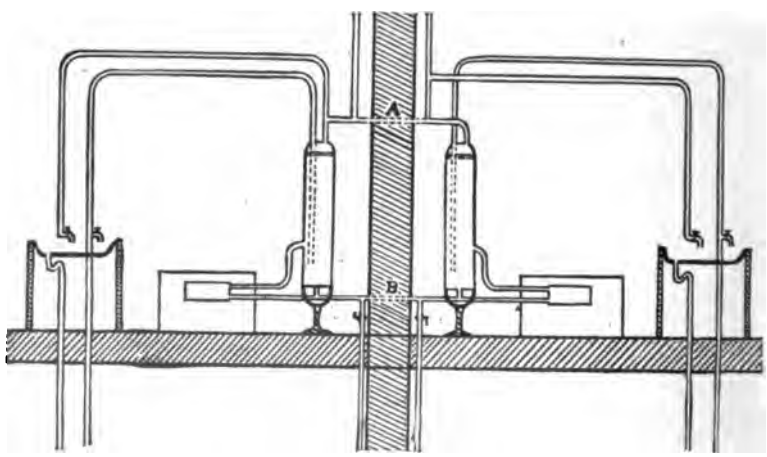


FIGURE 155.

House No. 2, kitchen is in constant use, as the cooking is all done for both houses in No. 2 kitchen. Now, what is wanted is to connect these two houses together so No. 2 will assist No. 1 in having hot water there three or four days when No. 1 range is not in use, and so they will both work in harmony with each other at all times.

I would be very much pleased to have your views on this subject.

A. Connect the hot-water pipes from both boilers, as shown by dotted line A, and cold-water pipes to ranges, as shown by dotted line B.

CONNECTING ONE BOILER WITH TWO RANGES.

Q. I SEND you herewith a drawing showing a method of fitting up a boiler with two ranges so as to be heated from either or both at once, thereby securing a good circulation, as I question if the water-backs would have a sufficient supply through the ordinary coupling when both ranges were in use at the same time. They would likely been pleasant on account of noise, if not dangerous.

When only one range is used the cold-water pipe is brought into the water-back through the end nearest the boiler, and the hot-water pipe is carried out from the opposite end, and around behind the range between it and the brick-work, keeping at about the same level till near the boiler, where it rises and enters the side-connection.

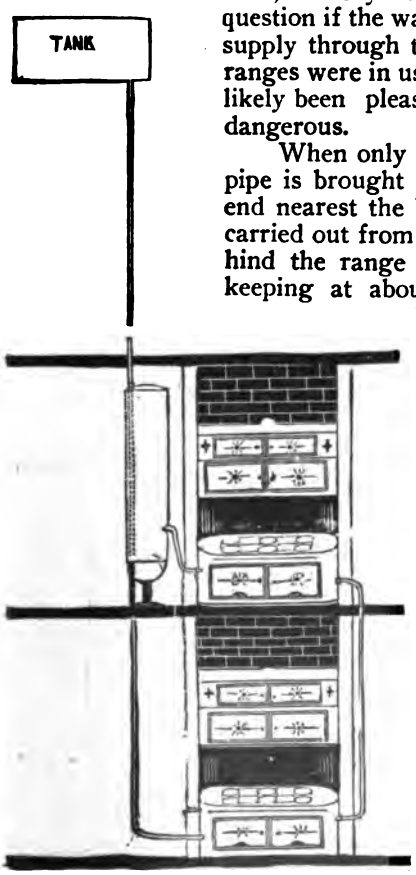


FIGURE 156.

A. The objection to this method is, as much water cannot be warmed by passing it first through one back and then through the other as would be the case if each back circulated separately to the boiler. This will be plain when we consider the water cannot take as much heat from the upper back as from the lower one, as the difference of temperature will be less between the water in the upper back and the fire than it will be in the lower one.

TAKING RETURN BELOW BOILER.

Q. I THINK the plumber is right and you are wrong about your advice to Mr. ———, when you say you can carry the return below the floor and then rise to the boiler and have circulation. If he does

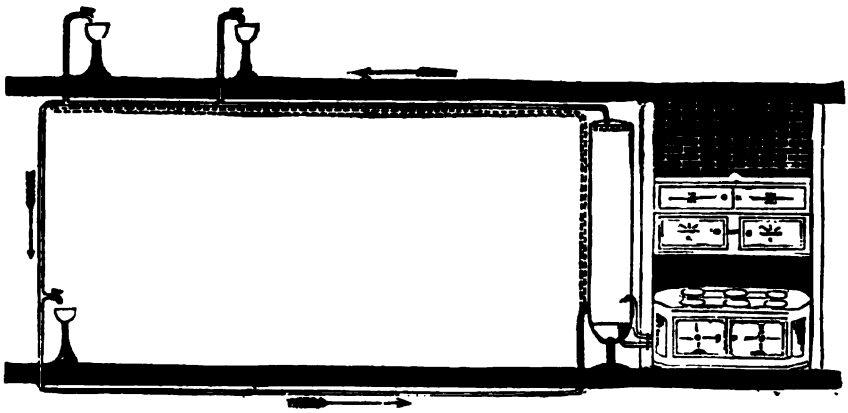


FIGURE 157.

as you say he will get a trap where he rises, and the cold water will stay there and he can't get any circulation. I don't think it makes much difference how high the circulation is, either. I would say to Mr. ——— it is a waste of time and money to run the circulation-pipe as he wants to do it.

A. We must still maintain that a circulation will take place in the pipe below the floor. It depends, as stated, on the cooling of the upper or flow-pipe. Then the density and the weight of the colder air in the descending pipe are greater than in the rising pipe, and it is this greater weight which causes the circulation.

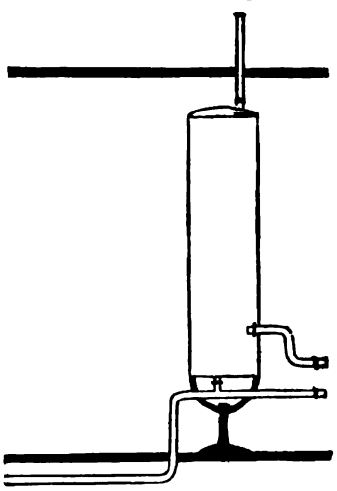


FIGURE 158.

We, of course, are not to be understood as maintaining that a circulation will take place at every distance below the water-back, and under all circumstances. How far below the water-back the return can be carried will depend on the height of the rising column. In the case submitted it is assumed that the upper pipe is

at least six feet above the water-back, and the lower pipe not more than three feet below it.

Figure 157 represents the plan we first proposed. Figure 158 is the method suggested by a firm in New York City which has had extensive experience in the fitting up of hot-water apparatus. It will be seen that the lower return is here connected with the water-back return-pipe.

AN IGNORANT WAY OF DEALING WITH A KITCHEN-BOILER.

Q. I PUT in a square boiler, holding about 25 to 30 gallons, in a country place, where it has to be filled with water from the top by the pailful. Now, the cold water passes through pipe No. 2 and through the water-back, and is heated and passes through pipe No. 3 to the sink. What is the reason that when the cock is open steam comes out for a minute or two and then the water comes out half-stream, and the water-hammer commences and acts on the boiler? What is the reason of this water-hammer, and how can it be stopped? and can the pressure be made greater?

This is the way the pipe runs. There is ½-inch 2 A A lead pipe. Don't you think there is water enough in the boiler to make it come out full stream into the sink?

A. The ignorance of the first principles of what is necessary to secure a hot-water supply for plumbing fixtures expressed in this letter and sketch is astonishing. Water is run from a tank into a water-back, and no provision is made for a return-pipe for the water to find its way back again to the tank when it becomes hot. The result is, you make steam in the water-back when there is sufficient heat in the range. This pressure, presumably, finds vent (backward) through the pipe No. 2 periodically and spas-

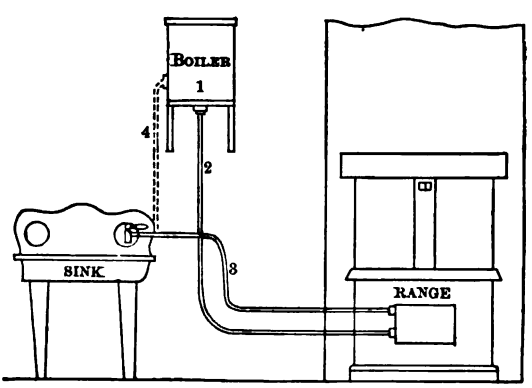


FIGURE 159.

modically, and with all the other symptoms of internal convulsions. When you open the cock at the sink the steam finds vent in that direction, the water following from the tank into the water-back. This condenses what little steam there is left, and a vacuum is formed, drawing water, air, or anything present in the pipes into the water-back, with all the phenomena of water-hammer or shock following.

It is a good thing the tank (or boiler) had to be filled through an open cover, for had it been a closed boiler it is more than likely we would have to chronicle the death of a servant girl or two, or may be a plumber.

Make a connection as shown by our dotted lines at No. 4, and see if it improves the condition of your apparatus. The water in the boiler must not be allowed to fall below the upper end of this opening.

It will be understood that the dotted lines are added by us. The original drawing and description makes no provision even for the ordinary circulation to and from water-back and boilers. It would be still better if the sink faucet was disconnected from pipe No. 4 and another pipe was taken out of the boiler above the pipe No. 4 and carried directly to the faucet.

RETURNING INTO HOT-WATER SUPPLY-PIPE.

Q. I PROPOSE to put in my house a circulation-pipe, attached to the range as follows:

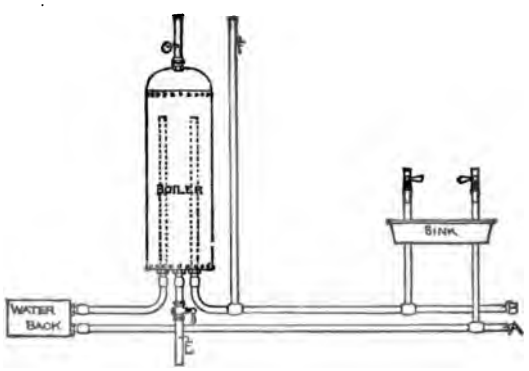


FIGURE 160.

A, cold-water supply from street; B, hot water from boiler supplying several fixtures in basement; C, hot-water supply for upper

floors; D, hot-water pipe from range to boiler; E, waste-pipe from boiler; F, circulation-pipe united to the pipe B and extending upward and uniting with the pipe C above the highest hot-water fixture.

The point on which I have doubt is whether the fixtures in the basement will injuriously affect the circulation through the pipe F. If you will kindly enlighten me, you will oblige.

A. There will be no interruption of the circulation in the pipes C and F, which will be apparent. Of course, water drawn at the sink, if drawn slowly, will have its temperature perceptibly affected by the return water from F, as it will mingle with it, but with ordinary use, with a good water-back, it should not be noticeable.

STOP-COCKS ON HOT-WATER PIPES.

Q. Is it safe to put stop-cocks on the hot-water pipes from a boiler, so that in case of bursting pipe, or other reason, water can be shut off? If not, what is the reason, and how can precautions be taken?

A. It is safer to have no stop-cocks on hot-water pipes. If the stop-cock on the cold-supply pipe to the boiler is closed, there would be no pressure on the hot-water pipes, which pipes could be emptied by opening the hot-water faucet over the sink.

WHERE SHOULD SEDIMENT-PIPE FROM BOILER BE CONNECTED WITH WASTE-PIPE?

Q. Do you think it proper to connect the sediment-pipe of a kitchen-boiler directly to a soil or waste pipe?

A. If the sink-trap is below the floor it is better to run the pipe in above it. If not, we see no serious objection to connecting with the waste-pipe. Of course, the sediment-cock should not be left open if the boiler were emptied of water at any time.

SEVERAL FLOW-PIPES AND ONE CIRCULATION-PIPE.

Q. I FIND it necessary to run three distinct riser-pipes from kitchen-boiler to the second and third floors. Can I secure a circulation by running a single return-pipe having branches connecting with each riser above the highest fixture? Would more return-pipes be any better?

A. Bring the branches E and F into the return D at slightly different levels to prevent the circulation in one meeting and checking that in the other, as they would do to some extent, certainly, if connected as shown. At the junction of G and D let G turn downward, so that the circulation in D may not be, in part, diverted into G, to prevent a circulation in the latter pipe. Then with a return-pipe large enough to carry the circulation in the three hot-water pipes you should get a circulation. We would advise that you make the pipes from boiler to junction a size

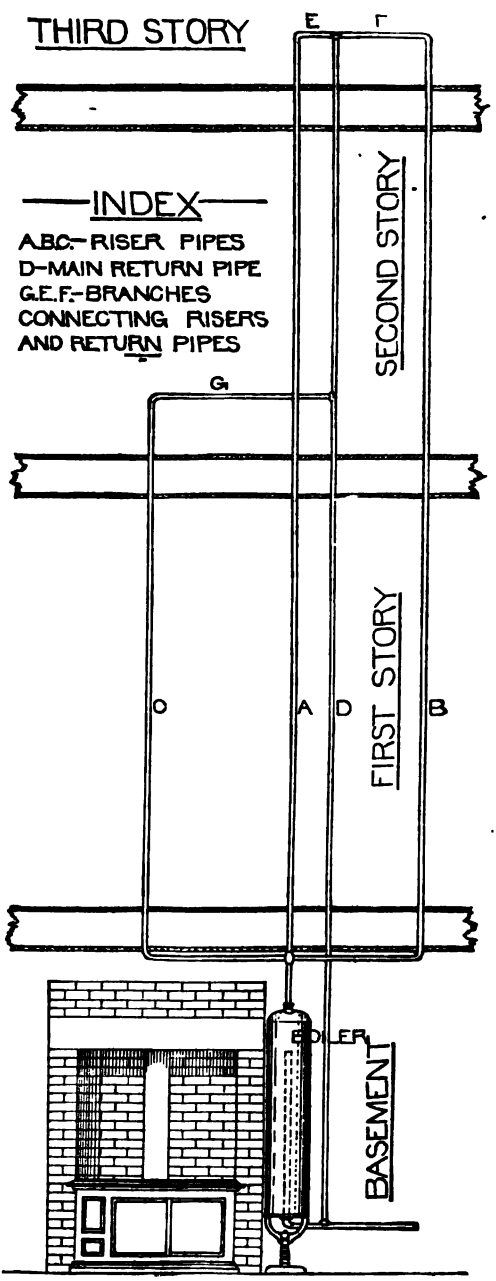


FIGURE 161.

larger than the pipe A, otherwise there is risk that the greater part of the circulation will take the easiest course through A, as that is in direct line, giving you little or no movement in B and C. If you intend to use iron pipe, Y-branches or "division-tees" will give better results than plain tees.

If the work is to be lead pipe, the good judgment of the plumber must be exercised in making easily-flowing joints, which direct the water in the proper direction.

HOT-WATER CIRCULATION WHEN PIPES FROM BOILER PASS UNDER THE FLOOR.

Q. I INCLOSE drawing of boiler, pipes, and tank, as shown in Figure 162, which I have tried, but it will not work. I then cut off the return hot-water pipe or circulating pipe, marked *c*, which ran to the bottom of boiler, and connected it to the circulating-pipe of stove and boiler, as by dotted lines, and it still will not work. The pipe can't be run on kitchen-ceiling nor over ceiling on floor. Evidently we must run through floor to cellar-ceiling, and up in partition to tank and bath-room. Can you inform me how to make a circulation work without changing the whole line of pipe? If you can give me any information concerning the circulation it will oblige me very much.

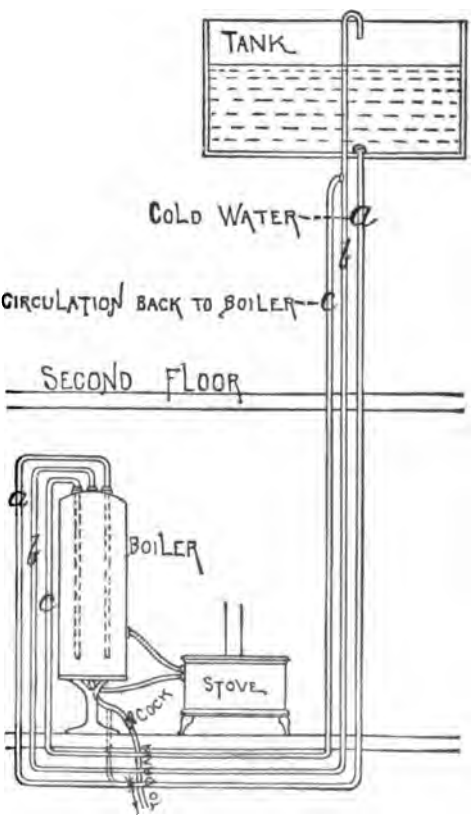


FIGURE 162.

A. Any circulation which has to drop after leaving the boiler is a thing of doubt, as there are so many circumstances which may affect the flow besides the actual direction of the pipe. When the pipe which has to convey the water

away from the boiler has to take a downward course, or the pipe returning to it again takes an upward one, they separately and collectively preponderate against the force which naturally tends to assist the circulation. In your case, in *b*, from the boiler to the under side of the floor, the water is the hottest in the circulation, and would naturally rise, whereas it must go down to accomplish what you want. But in *c*, for the same perpendicular height, it is the coldest, as it is the end of the circulation, and would naturally fall where it is forced to ascend to accomplish what you desire. Thus, in these two pipes, from the boiler to the under side of the floor, you have a preponderance against you. In the pipe *b*, where it rises in the house again, you have a hot pipe, but not as hot as where it runs in the wrong direction at the boiler, and in juxtaposition to it you have the return pipe *c* colder than it, though not very much so, and warmer than the pipe *c* where it rises. These pipes at this point tend in the right direction, but the difference of weight of water between them is not sufficient to overcome the difference which works against them in their course in the vertical position near the boiler. Air will also collect in the dip to impede circulation.

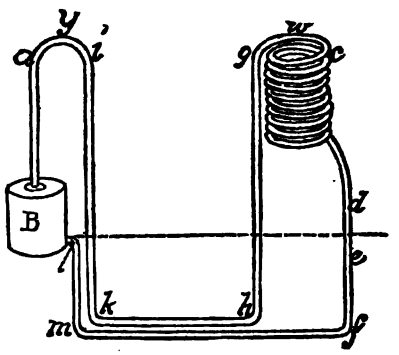


FIGURE 163.

If you clothe a flow or hot pipe where it ascends, and a return or cold pipe where *it also ascends*, and all level pipes, it will assist a circulation, as by that means you prevent a great loss of heat at these parts, and keep the column of water nearly the same temperature and density throughout its length, allowing it to cool only where cooling will tend to quicken the circulation by increasing the density—namely, where flow-pipe or return-pipes fall, but notably the latter. In your case, if *b* and *c*, where they run upward, could be extended indefinitely, you presumably would reach a point where the circulation would go on, and which Mr. Armstrong must have exceeded in his case, or his job in the Young Ladies' Seminary at Northfield, Mass., would not have worked. There may be influences at work, also, in his case, assisting him, such as a large quantity of cooling surface in his return-pipe compared to the bulk of water it will hold,

or its being run in a position where the influence of cold draughts or cold pipes affects it. The method of entering the boiler at the bottom with the return-pipe is better than carrying it down inside in a tube.

We do not recommend this method of getting circulation, and no one should attempt it unless it was an impossibility to run the pipes any other way. Hood, in his treatise on warming, etc., says: "In Figure 163, B represents the boiler; and the effective or direct motion is in this case caused by the water in the coil and pipe *c d* being so much heavier than in the boiler and the pipe B *a* that it overcomes the retrograde motion which is produced by all the other parts of the apparatus. Thus the water in *g h* being *heavier* than that in *i k*, and that in *e f* (below the dotted line) being lighter than that in *l m*, has in both cases a tendency to retrogression. * * * The motive power, therefore, entirely depends upon the quantity of heat given off by the coil; for the water must be cooled down many degrees in order to give it sufficient preponderance over the water in B A to cause a circulation."

THE OPERATION OF VACUUM AND SAFETY VALVES.

Q. WHAT is the principle on which the "safety and vacuum valve" on top of a boiler acts, and how should it be set?

A. A vacuum-valve on a kitchen-boiler is intended to prevent the collapse of the boiler by the pressure of the atmosphere on its outside, should it become empty or partly empty through the shutting off of the water-supply; at the same time, should there be a heavy fire in the range, steam may be generated within the boiler, in which case a safety-valve is intended to let the over-pressure escape. It also provides for the expansion of the water should a fire be started with a full boiler and pipes, with the street-cock accidentally shut. The annexed cut shows how a combined "vacuum and safety valve" may be set.

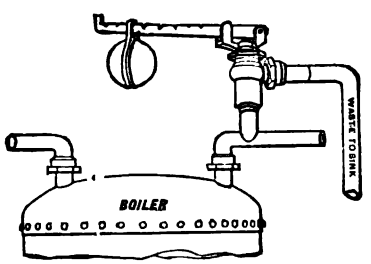


FIGURE 164.

For hot-water boilers in houses we much prefer to have an

open-end relief-pipe, to prevent vacuum and explosions, to trusting to vacuum or safety valves, because, unlike the valves on steam-boilers, they are not often tested, and when wanted they do not always work.

VACUUM-VALVES NOT ALWAYS RELIABLE.

Q. My recent inquiry, to which you now very kindly reply, was prompted by the fact that in a new building fitted with a copper boiler of the best make, supplied with the safe and vacuum valve of your illustration, the boiler suffered a total collapse when the water company suddenly turned off the water, a few days before the date of my letter. The water company promptly replaced the boiler with a new one, because they neglected to give notice of their intention to turn off the water; but I now desire to learn whether or not such accidents are preventable. I always use the open-end relief-pipe where there is a tank to carry it above, but when you have city water at 45 pounds pressure what do you do?

A. It would seem that your experience justifies our opinion that it is not always safe to rely on safety and vacuum-valves on range-boilers. Under the conditions named by you—viz., that you have a public water-service with an average pressure of 45 pounds to the square inch—we should advise you to take this supply to a tank, controlling it by a ball-cock. Then take your supply to the boiler from this tank, returning the hot-water pipe above and over the tank as a relief-pipe. You can then use copper boilers with safety.

The only other plan is to use galvanized-iron boilers. This is cheaper, but not so desirable, although generally done. How your water will be affected by contact with galvaized iron you can ascertain by trial.

COLLAPSE OF A BOILER.

Q. In drawing the water from plumbing fixtures, arranged as follows, or similar to Figure 165, the boiler collapsed. Was the siphon enough to do it, or could there have been another cause?

The circumstances were as follows: The main pipe from street to tank was shut off; then a hot fire was removed from the range; all the water was then drawn from the tank through the faucets in the sink; a ½-inch hose was attached to the sediment-cock, and the cock opened; then the drip D in the hot-water pipe in the cellar was opened, from which some water flowed. Hearing a peculiar noise, on going to the kitchen, the boiler was found to have collapsed.

Could there have been any pressure in the boiler to have forced the water out of the drip and hose also? Or was not the boiler strong enough to resist the power of the siphon, which would have existed until the water lying in the hot-water pipe was drawn into the boiler?

The fall is as given in the diagram. Shall have an air-cock placed in top of boiler when it is replaced.

A. The siphon action was sufficient to collapse the boiler, and probably did so in this case.

When you drew the water from the boiler and pipe through the sink connections you still left the pipes and boiler nearly half-full, as indicated by the dotted line *a*, but when you attached the hose you made the long leg of a siphon, which for the height of six feet, as you show, and say three feet added for the height of water in the boiler and connections, gave you, we will say, a pull of four pounds per square inch. Against this you had a column of water raised in your hot and cold pipes alongside of the boiler by, we will say again, the "pull of the long leg of the siphon." Assuming the latter distance to be nearly equal to the other, which, it appears from your diagram, you may safely assume, you had an atmospheric pressure of three pounds per square

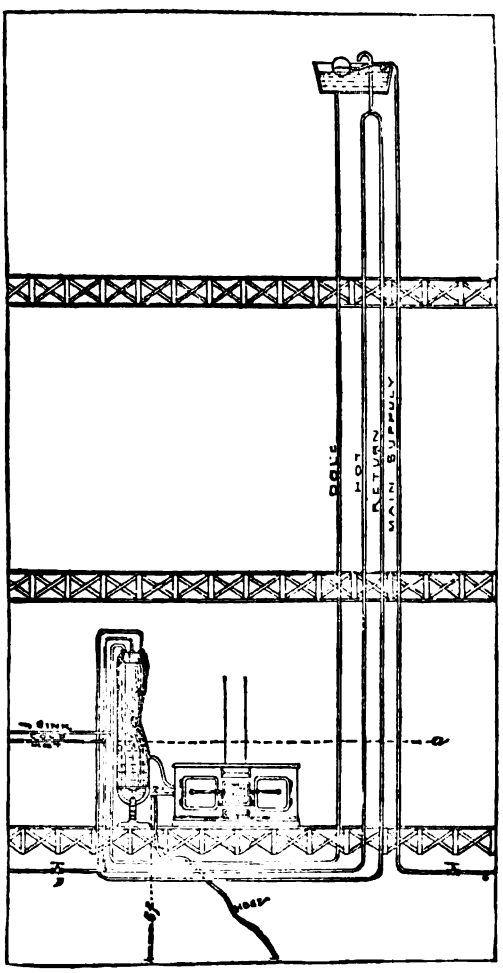


FIGURE 165.

inch, or what would produce it. You opened your hose, or the long leg of the siphon, *first,* and air did not enter through your sink-cocks, as they must have been closed. Had you opened the cock D first (the short leg of the siphon), you probably would not have had the collapse, as the small quantity of water it contained would have run out. When you did open it air entered by it, and made the noise you mention. Had the sink-cock been left open the whole trouble would have been avoided.

PREVENTING COLLAPSE OF BOILERS.

Q. WHAT precautions can be taken against the collapse of kitchen-boilers, when water is drawn off in the street-mains?

A. Put out the fire in the range and close the stop-cock in the service-pipes, so as to prevent the water running backward into the empty mains, and draw no water in the house until the street-mains are full again. It is better to supply the boiler from a tank or supply-cistern instead of from the mains direct, and have an open pipe carried from the top of the boiler to above the level to which the water can possibly rise.

EXPLOSION OF WATER-BACKS.

Q. THE excessively cold weather of any winter is likely to give the usual trouble in regard to the freezing of pipes from boilers to water-backs. In Chicago, in one instance, the explosion of a water-back was attended with loss of life.

I have had to disconnect my boiler and stop its use altogether, owing to the impossibility of preventing the freezing of the connecting pipes.

On two occasions, recently, the pipes were found frozen, and only by the personal precaution of thawing out the pipes previous to lighting the fire was an explosion avoided. I write this to ask you if it is not possible to devise some contrivance, such as a plug of fusible metal, or a cock to open at a high pressure, which, placed in the water-back, would obviate the danger of explosions when the connecting pipes are frozen, thus putting our cooking-stoves and their hot-water attachments within the intellectual range and ordinary care of our usual hired help.

A. We know of no contrivance that can be depended on in emergencies such as you suggest. The only plan is to keep up a good fire and not let the pipes freeze.

A PROPOSED PRECAUTION AGAINST WATER-BACK EXPLOSIONS.

Q. THE usual catalogue of accidents from exploding water-backs, caused by freezing, has begun to appear in the papers. This suggests to me whether there is not a simple expedient by which the servants may ascertain whether the water-back connections are frozen or not. I would suggest the following for your consideration:

As close to the range as possible put a cock, A—Figure 166—not in the line of the connection, but opening from it, so that by no accident can it shut off the connection. Let this pipe terminate, say, over a pan, and let the servant every morning try the cock before starting the fire. If water will not run from this cock it will be clear proof something is wrong, and then the process of thawing out the connections, together with a very slow fire in the range to gently heat the back, can be proceeded with until water runs from the cock A. Would it not be worth while for range-makers to provide such a cock in connection with the spuds for the water-back connections?

A. In the hands of an expert, or with very cautious persons who had been specially instructed in its use, the plan suggested might prove of service. It is reasonable to suppose that the water in the pipes leading to a water-back will freeze before the water in the back can; and that if the cock mentioned ran water when opened the pipes would be clear, and that, consequently, the back would be also unfrozen. But its practical value, we think, would be very little, for the simple reason that people who blow up water-backs have generally very little knowledge about such matters, and would not know what to do if they were informed a water-back was frozen. In fact, they would be apt to reason that the heat of the fire would thaw all out.

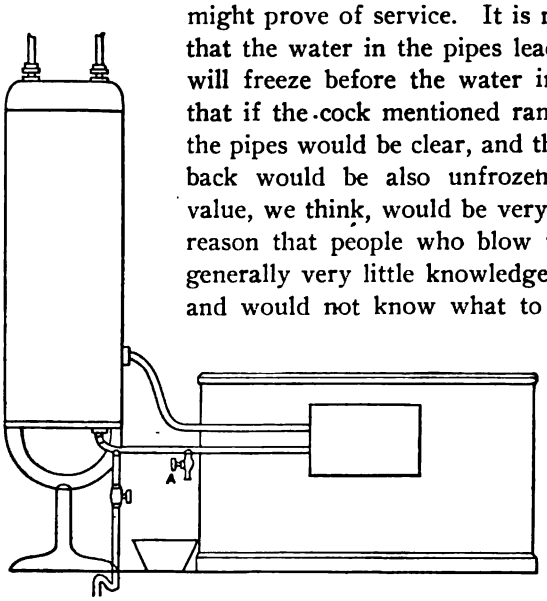


FIGURE 166.

What is really wanted is a water-back that will not explode, or one that will explode at a comparatively low pressure. When the ordinary *box-casting* explodes the pressure necessary to

burst it is seven to eight hundred pounds per square inch, or higher, and is capable of doing about as much damage as a bomb-shell, by the expansive force of the heat contained in the water necessary to exert such a pressure, the water flying into steam upon being liberated.

To lessen the extent and force of explosions in water-backs, pipe-coils might be used instead of box-castings, if it were not for the fact of their filling with lime-deposit, etc. With the pipe a bend may split or the pipe burst, but the whole thing will not go to pieces, and the discharge will be more gradual, resulting, it may be, in blowing the covers off the stove only.

THE BURSTING OF KITCHEN-BOILERS AND CONNECTING-PIPES.

Q. I HAVE a boiler connected with a stove which causes a terrible rumbling whenever they draw water from the cold faucet, and it is bound to burst the pipe or boiler somewhere. Connections are all heavy lead pipe. I sent you sketch of work (Figure 167). Please advise me, and oblige.

I have marked where it bursts; it is street-pressure, and these are all the connections in the house which you can see; 1¼-inch iron pipe is used for water-heater. Do you suppose the trap in stove causes it?

A. We think there are several good reasons why the pipes or the boiler, especially the first, when made of lead, should burst in an apparatus designed as that shown in your stretch.

The bursts in the pipe are due to the changes the lead pipe is subjected to, by frequent and extreme changes of temperature under pressure, due to your boiler being too small for the water-back; or the state of your fire or the efficiency of your water-back is too great for the intermittent use that is made of the warm water.

When a kettle of water boils on the top of a stove and blows the cover off, or ejects steam and water from the spout, the cook removes the kettle or adds cold water. When she removes the kettle she places the water already in the kettle, which has received all the heat it should, beyond the influence of the fire. When she adds more cold water she still leaves the kettle-bottom in a position to receive more heat, but as she has added water that is capable of absorbing considerable heat before the kettle again boils, she gains

time by the operation, and has a larger supply of hot water on hand. Or, in the case of adding water, she may, when she finds the kettle boiling, should it be full, draw half of it off, and fill it up with cold water, in either of which cases she gains time and warms more water.

In many respects the range-boiler is similar to the water-kettle, and in others it differs from it. One point of similarity is that both are reservoirs; another is, the kettle receives heat through its bottom by the freest of circulations, while the boiler receives its heat through the "water-back" by a circulation which is more or less good, according to the skill and knowledge with which the connections are made.

The most striking point of difference is that when the kettle boils the cook can take it off the fire, but with the range-boiler it is beyond her power to prevent its receiving more heat short of putting out the fire, and there is nothing left for her to do but to run hot water in the sink until enough cold water passes into the boiler to reduce the temperatures all around, and which may perhaps carry her to a time—after dinner, for instance—when the fire will be poor, and she will not have to attend to it. But it will be said that such a state of affairs it not the rule with kitchen-boilers, which is very true; but the reason it is not the rule is that most kitchen or range-boilers have surface enough on their outside to counteract the warming and heating effect of the water-back long before the water reaches a point to make steam. Or if they have not cooling surface enough on the outside of the boiler, they have long circulating-pipes which carry warm water to distant parts of the house and return it again, every square inch of which is efficient heat-dissipating or giving-off surface, which is

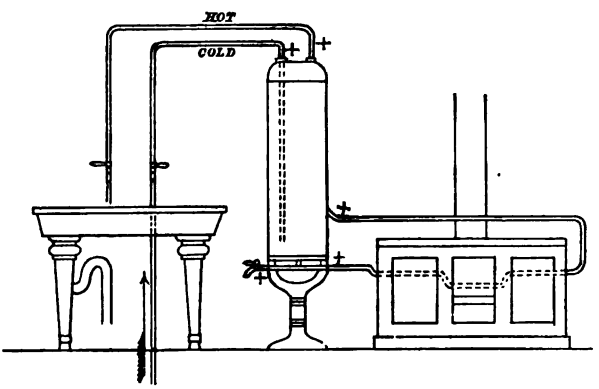


FIGURE 167.

continually counteracting the efforts of a smaller but more intense heat-absorbing surface in the water-back. Rarely do we hear of overheating and rumbling except where there is a defective cooling circulation, or no circulation at all. It has been pointed out that properly there were *three* circulations in connection with a domestic boiler. The first and principal one, which must always exist, is *the circulation through the water-back;* the second, a *local circulation* in the boiler itself, due to receiving the primary circulation from the back into the boiler well down, instead of at the top; and a third circulation, which takes place in the distributing-pipes. The first circulation is a heating one only; the second is a mixing and cooling circulation, because as the water moves around within the boiler, fresh particles of it are brought against the outside, where it loses its heat; and the third one, when it exists, is always a cooling circulation.

The influence of the second circulation in a cool kitchen with an ordinary-sized back is generally sufficient to keep the temperatures under control, but in restaurants and other warm places, with strong fires and no third circulation, nothing but a very large reservoir (boiler) will do, as by that means a greater quantity of water has to be warmed in the first place, and larger cooling surface is maintained for the secondary circulation to act on.

In your case, in addition to having too much back for the boiler, or too little boiler for the back, whereby you get the water up to the point of making steam, you have nothing like an air-chamber to receive the force of the shocks caused by the concussions which follow drawing water when steam is evolved. When you draw hot water, cold water passes into the boiler, and a succession of short quick blows evidently follows. The act of drawing water lessens the pressure, and the water in the boiler, which is already at the boiling point, gives off steam suddenly. It is this steam which makes the water-hammering when being condensed as it meets the colder water.

The violent and sudden changes of temperature also assist in the disintegration and stretching of the lead pipes. The trap in the water-back is something we do not like, as its tendency is to retard this circulation, but in your case you evidently do not want to increase the primary circulation, and unless it is necessary to alter the coil for some other purposes it will do.

Hard-metal pipes (brass or iron) will resist the stretching from difference of temperature and pressure better than the lead, and a

larger boiler may overcome the other troubles, such as noise, etc.

The rumbling caused when cold water is drawn is also due to the lessening of pressure whereby the steam passes into the cold-water pipe at the head of the boiler through the small hole in the inner pipe. Condensation follows, and a succession of small shocks is felt.

CONNECTING A KITCHEN-BOILER WITH ONE OR MORE WATER-BACKS.

It frequently happens that the kitchen-boiler must be connected with two or more ranges. Sometimes the reason is that the water-back in a laundry-range must be connected with it for the purpose of getting more hot water on washing days, and again it frequently happens that a winter kitchen is on the first floor of a house, and that the summer kitchen is in an extension or in a basement. This sometimes happens and admits of several combinations. Sometimes they are a matter of choice, but more often of necessity.

When one range is in an upper room above another range in a room below, the diagrams *a, b, c,* and *d* illustrate the principles involved in the forms usually met with.

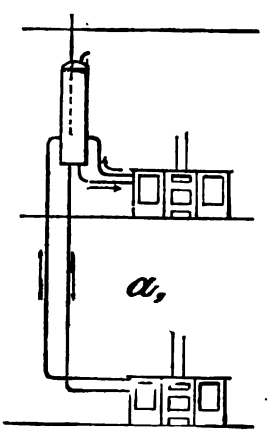


Figure 168.

Diagram *a* is used when a boiler is provided with *two* side couplings and *two* bottom couplings, one set for each range. This requires just a little forethought and the knowledge that two water-backs are to be used. The increase in cost is inconsiderable, and it permits of entirely separate connections, which can in no way interfere with each other by influencing the flow of the water in either. From the lower water-back the flow of water will be more rapid than from the upper one, assuming they are alike in size and construction. The reason for this is that the up-take or flow-pipe and its return-pipe are so much longer, perpendicularly, than the same pipes from the upper water-back, that there is a greater relative difference of weight between the up-take and its corresponding *return,* that this difference increases with the increased lengths of

the pipes, but in a very much inversed ratio, but still considerable and very marked to an observing plumber.

This (*a*) presumably is the most suitable connection for double ranges, but under one condition, at least, an objection has been made to it. It is claimed that should the lower range be in a cold or exposed place, and no fire in it, the water in the water-back and in the pipes leading to and from it will be inert—that is, have no circulation—and that they may freeze. This presumption is reasonable, and a method of securing a circulation from the boiler through them sufficient to prevent freezing is something for thoughtful plumbers to take into consideration.

In the case of the upper water-back and pipes freezing when the lower one is in use, the danger is not so great. The heat of the boiler is generally sufficient to warm the room beyond the danger of frost, and should the dampers of the stove be closed, so as to prevent a strong draught over the water-back, the danger is reduced to a minimum.

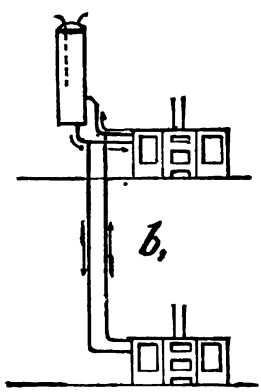


FIGURE 169.

Diagram *b* shows the method generally followed when there is but one set of couplings on the lower part of the boiler. It is claimed by some that with this arrangement of pipes the water in neither back can freeze so long as one of the ranges is in use. It is claimed, for instance, that should the upper range be in use, the hot water flowing from the back into the boiler will draw the water from the lower back by induction, as it passes over it, thus keeping up a circulation through it from the return-pipe. However, this may be questioned. Of course, one can imagine how the stream of warm water from the upper range flowing over the end of the up-take pipe from the lower one may draw water out of it; but if we look a little further we will also see how the return-current to the water-back in the upper range will also be trying to draw water from the return-pipe to the lower water-back by the very same inductive principle which is applied to the other pipe, and that they may be assumed to balance each other and make abortive any claim that can be put forth for the principle. However, it may be that some accident of

construction—some peculiarity of the making of a joint in lead pipe, for instance—may make one of the joints at their junctions a more favorable *injector,* if we may use the word, than the other, and that by this means the water will move in some one direction, which is just as likely to be drawn up through the return-pipe and into the water-back as passing up through the flow-pipe and into the boiler. As said, in lead pipe this can be assumed as likely to happen, but with brass or iron pipe the conditions of the junctions will be always the same, and positive circulation in the lower water-back without fire cannot be assured.

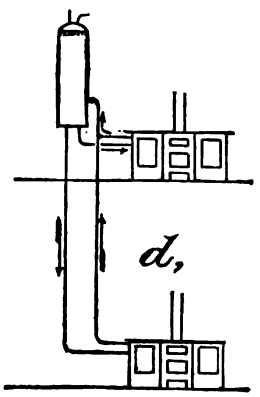


FIGURE 170.

Diagram *d* shows a method with which there is some hope of getting a positive circulation of the water through the lower back when the fire is out. It will be noticed that the flow-pipe from the upper back enters the flow-pipe from the lower one some distance below the side coupling of the boiler, and that there are two bottom couplings. The fact of there being *two* separate return-connections produces the result that there can be no inductive influence from one to the other on the return-flow in either. But, again, the fact of the upper flow-pipe joining the lower one at the level of the upper back makes it reasonable to assume that here an inductive influence may be at work. If instead, as in the diagram (*d*), the flow-pipe from the lower back entered the flow-pipe from the upper one, as in diagram *b,* there would appear to be no doubt of an induced circulation through the lower back. As *d* is now drawn, it is the most favorable for the inducing of a current through the upper back, if the lower range be in operation and the upper one cold.

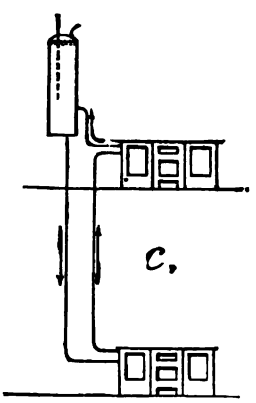


FIGURE 171.

Diagram *c* is a method which is claimed to be positive. The water is passed through the lower back first, then through the upper one, and into the boiler. When the lower range is in use this cannot be other than a positive method. On the

other hand, when the upper range only is in use, there is reason to believe this method will not circulate freely under all conditions, and that at its best it will not do as well as separate or branched connections.

The effect of this is to make a great *dip* or *trap* in the return-pipe. To have it circulate at all, the sum of the weight of water for a given height in the *two* flow-pipes—that is, the pipe from the lower back to the upper one and thence to the boiler—must be less than in the return-pipe, the perpendicular length of the return-pipe to be considered as just equal to the length of the combined flow-pipes; that part of the boiler below the side coupling being considered as part thereof. In this diagram (*c*), therefore, we have the water in the return-pipe of unknown density, but which we know to be less than in the flow-pipe between the water-backs, and greater than in the flow-pipe from the upper back to the boiler, having a power to produce the circulation, which we may illustrate this way: Assume the value or density of the water in the pipe between the two water-backs to be 100, as it is the coldest; assume the value of the down pipe to be 90, as it has not traveled so far nor through the water-back, and then assume the value of the water in the pipe from the warm back to the boiler to be 80. If we do so it will have $100 - 90 = 10 + 80 = 90$, or just a balance, and no circulation. If, on the other hand, we can give the pipe from the hot back to the boiler a value of 70 only, it will give a combined weight to this column only of 80, and as the corresponding cold column has a value of 90, the circulation will go on. But, again, if we give it a value of 85 we will have a heavier column in the uptake side than on the return side, and an irregular, spasmodic effort of the water and steam to pass into the boiler will be the result every time the water in the back gets hot enough to make steam and force itself into the boiler during the momentary change of value in the weights of the columns due to the steam. An objection to this method, should it be used for the purpose of an increased quantity of hot water, and if both the water-backs would be constantly in use, is that the water, after passing through the first back, has been warmed so much that it cannot extract an equal quantity of heat in passing through the second back, and that, consequently, *two* backs, separately connected to a boiler will warm more water in a given time than *two* backs connected in continuous order, as shown in diagram *c*.

Diagram *f* shows two ranges on the same floor connected with a single boiler. It is the usual method when there is only one side and one bottom coupling to the boiler, and when there are no doorways to pass. If the outer water-back is in a cold place there is almost always the chance of it freezing, as with *b*, because the inductive influence of the flow through the hot pipe from the near water-back is neutralized by the influence of the return flow in the return-pipe. A double coupling in the bottom, as shown in *d*, will prevent this.

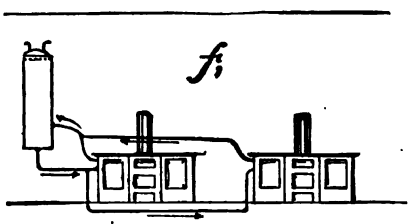


FIGURE 172.

Diagram *e* shows a method of connecting two ranges with the same boiler when a doorway has to be passed. It is not absolutely necessary that the flow-pipe from the first water-back should be connected as shown, as it may enter the usual side-coupling which is on all boilers, but it is necessary that the flow-pipe from the range beyond the doorway should enter the boiler as high as where it passes the doorway. Should this pipe be carried down to the side coupling, the chances are the circulation will be spoiled by an accumulation of air in the top of the siphon, or very much checked in its speed by the too nearly equal weights of the rising and falling columns.

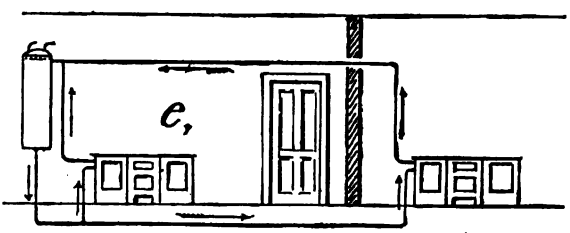


FIGURE 173.

The higher the flow-pipe from a water-back can rise before it enters the boiler—provided it is not exposed to the influence of cold air—the more rapid the circulation will be and the more water that can be warmed in a given time, the water-backs being equal in every other respect.

The same laws that are true of circulation in a hot-water house-heating apparatus are also true of boiler circulations.

With diagram *e* it would be better to have one side-coupling at the top of the boiler, and two bottom-couplings, with a separate re-

turn. This would insure an inductive movement of the water in the range not in use and give the maximum effect in warming water. But this not only applies here, but to all boilers. The side-coupling of the ordinary boiler is too low down, if one desires to secure the best results with a given size of water-back. The rapidity of circulation depends on the difference in weight in the two columns. The longer these columns are the greater the difference will be. Again, the power of a water-back to absorb heat increases in a proportion nearly equal to the increase of velocity of the water up to a point which can never be obtainable with any but mechanical or forced circulations.

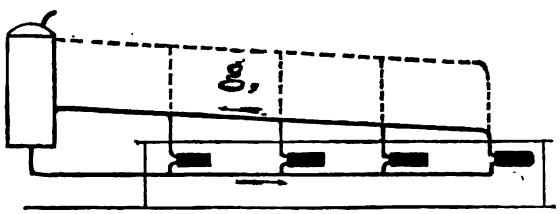


FIGURE 174.

Diagram *g* shows a method used to connect a large kitchen-boiler with more than one water-back in a long range, such as is sometimes used in a large institution or hotel kitchen, where much hot water is required, but there is no means of making it with steam. This shows the ordinary coupling arrangement, and it is probably the best connection that can be made with two couplings with the minimum of pipes. But the dotted lines show a method which will warm water much more rapidly.

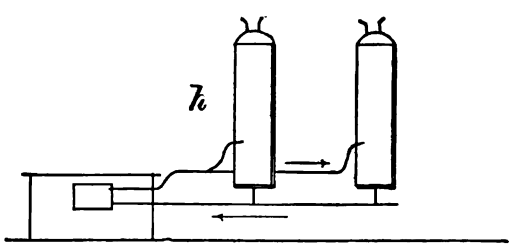


FIGURE 175.

It now and then happens that a plumber has to connect two boilers with one water-back. This, on general principles, he is opposed to doing, but it frequently happens that the maker of a range objects to putting an extra back into it, especially if he has to remove any of the fire-brick lining to do so, usually claiming that it will spoil the baking properties of his ovens, and he will allow the use of a coil or extra back only under protest.

To take out the single back and replace it with two small ones is

no better than to connect the two boilers to the single back, because, as a general thing, the surface of the backs cannot be increased. Therefore the plumber is compelled by circumstances to do the best he can with the range and back as he finds them. He might, of course, tap extra holes in the back—*two* flow-holes at the top and *two* return-holes at the bottom—but then it entails extra expense and trouble and alterations in the stove to get both sets of pipes through to the boilers, and thus he is forced to connect two boilers to a single water-back.

Diagram *h* is the way it usually suggests itself for the first time. It is the simplest, and all the flow pipes have an upward tendency toward the boiler, with a level return-pipe, or it may be that the plumber can secure a little pitch toward the water-back.

This will work tolerably well if the two boilers are very near together—that is, the first boiler will heat fairly well, and the second one not so well, but as it is furthest from the range it is hardly to be expected of it, either in the opinion of the man who puts it up or the user; and hence the differences of temperature and the time of "warming up" are looked on as a natural result, and past correcting, at least with the majority of people. But the limit of improvement in this direction has not been reached, and it has been found that a simple change, such as that shown by diagram *i*, insures equal temperatures to both boilers. The flow-pipe must be carried across some short distance above the "side couplings" on the boilers, and the side couplings should be set so as to be on the same level. The flow-pipe should be made large after it leaves the range—say twice the diameter of the side-coupling connection. It should also be perfectly level beyond the point where it reaches its greatest height, just close to the range, and the branches which connect with the side couplings should be taken out in the same manner from the flow-pipe, and dropped a few inches before entering the boiler. By this method the flow-pipe has considerable capacity, and becomes a reservoir of hot water of prac-

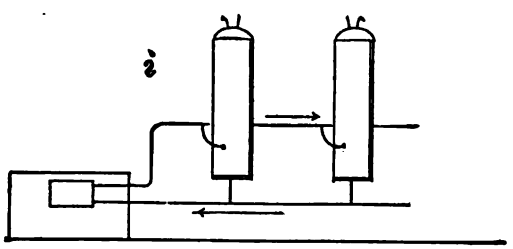


FIGURE 176.

tically the same temperature throughout. From this pipe the water to the side connections will descend by gravity, due to cooling, and the whole distance between the level of the flow and return-pipe, in a line through the boilers, forms the "down" legs of the circulation, while the "up" leg is the rising pipe from the water-back and the back itself. This method balances the conditions for both boilers, and each receives the same amount of the flow.

By using a large flow-pipe, a very considerable distance may be maintained between the boilers, giving results so nearly equal that the difference cannot be detected by the hand. This method forms a siphon, in the head of which air or steam might lodge when they are present, and for this reason an air-cock or branch to a sink should be run from the end of the flow-pipe. Generally this will not give trouble when the air is once drawn out, and with two boilers steam can scarcely be formed with an ordinary-sized back.

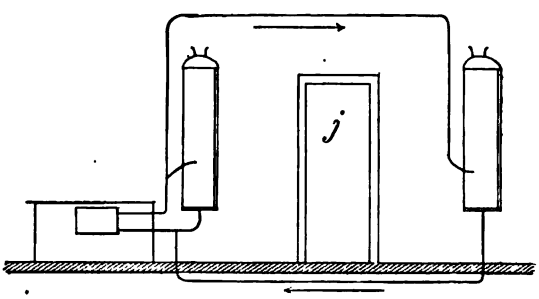


FIGURE 177.

Should one of these boilers be beyond a doorway, as it is very likely to be should it be in a laundry or other room, the fitter will find it necessary to run the flow-pipe above the door-way to reach the further boiler, returning under the floor. If he attempts this at all, he is very likely to run his pipes as shown in diagram *j*. He is likely, as he brings his pipe from the water-back, to run upward about as shown, taking a branch to the side coupling of the nearest boiler as he passes it, then run up and along the wall over the doorway, dropping as soon as possible to the side coupling of the further boiler. The return of the nearer boiler he is apt to run in the usual manner—taking it back above the floor. The return of the other boiler he is forced to carry below the floor, to prevent a stumbling-block at the doorway, and to enter the water-back with it he is most likely to connect it about as shown into the return from the near boiler.

The result of this is to produce a fairly rapid circulation through

the first boiler, with a poor circulation in the boiler beyond the doorway. As in the first case, it is likely to be looked on as something that cannot be avoided—in fact, a natural consequence. Let us consider why it is. The distance between the boilers is a factor against the further one, but, after all, not a factor of as great consequence as is generally considered. What are the other factors for or against the circulation? Let us dismiss the idea of a "push" from the water-back, and consider only the difference of weights of the descending and ascending columns of water. The circulation to the first boiler (diagram *j*) is up through the flow-pipe and down to the level of the back again through the return-pipe. This makes a *hot* "up-leg" and a *cooler* "down-leg," insuring a circulation of unknown velocity, but, nevertheless, a positive circulation in the right direction, and about equal to that in an ordinarily set single boiler. The circulation to the second boiler (same diagram) is also up, making a long *hot* "up-leg," thence across the doorway to a "down-leg," which can be very little cooler than the "up-leg," *if the circulation is to be rapid enough to maintain warm water in the boiler.* If the latter is the fact, then the up and down legs of the flow-pipe to this boiler nearly balance themselves, the preponderance being slightly in favor of the down-leg. But the return-pipe of this boiler has not yet been considered. Taking it from the bottom of the boiler, it again forms a down-leg (which, in its fullest sense, is a part of the down-leg of the circulation), and has a temperature somewhat less than the boiler. Then it flows across underneath the floor, and loses more heat, until it comes to rise again near the stove, where it forms an *up-leg* again, which leg is cooler than an equal perpendicular height in its corresponding down-leg just mentioned, because it has traveled further. This, then, gives a greater weight in the up-leg than in the down one, and a preponderance against the circulation. If, now, the factor in favor of the circulation in the down-leg of the flow-pipe outweighs the factor against the circulation in the up-leg of the return-pipe, there will be a circulation going on in the right direction. If, on the other hand, the factor against the circulation in the up-leg of the return circulation is the greater, the circulation will stop, or be extremely slow, until such time as the water in the down-legs of the flow and return can cool sufficient to overcome the resistance of the up-leg of the return, when there will be an intermittent circulation, or a *mean* (average) slow circulation established, which will be of no practical use as a means of warming water.

Diagram *k* shows a method for getting equal circulations of practical value in both boilers when one is beyond a doorway. The flow-pipe is carried from the back, of ample size, direct to the height of the doorway, and run to both boilers. The side-coupling connections are then dropped of equal size and distance. The returns from both boilers are dropped to an equal distance below the floor and carried back in a return pipe to the water-back, as shown, rising underneath the flow-pipe to enter the range. This gives precisely the same piping and circulation to each boiler, and prevents a "short circuit" by way of the first boiler.

To a critical examiner it may now appear that a method is put forward in diagram *k* for the two boilers that is very much the same as for the further boiler in diagram *j*, and the question is very likely to be asked, How is it that it will work on two or more boilers and not in the case of the single one? It does work in the case of the single one, but poorly: first, because the hot water makes a short circuit through the nearer boiler; and, secondly, because of the slow circulation to the further boiler, the rising legs cool more and lessen their power to ascend, and though the down-legs also cool, they do not cool in the same proportion, so as to equally increase the power to descend, for the reason that the hot pipe loses more heat per unit of surface than the cooler one, the loss being about directly as the difference of temperatures between the pipes and the air of the rooms they are in. For this reason the return-pipe beneath the floor should be covered to prevent loss of heat.

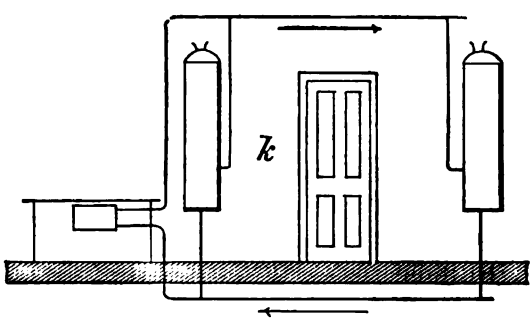


FIGURE 178.

With diagram *k* the very hot water from the water-back goes directly to the upper horizontal flow-pipe, which should be of large diameter. In the rarity and lightness of this vertical column, nearly all of the power to circulate exists. The quick passage of the water to supply two boilers through this pipe lessens the loss of heat to the

water of a single boiler—not meaning that less heat is lost per unit of pipe-surface, as that is constant, and therefore more nearly maintaining an equal density throughout its length. On the other hand, in the down-legs of the flow-pipes and "return"-pipes, the same quantity of water is divided between two pipes, and consequently it has a slower velocity and more surface and loses more heat; therefore becoming more dense, and adding to the power to move the up-column, or whole circulation. Then, where they merge into a single pipe again, the velocity doubles, and though the loss per unit of surface is the same, the loss from the water is only half what it would be in two upward pipes.

The distance dropped below the floor should be as short as possible and running in a box cut into the floor-joists, or running between them, and nicely packing with a non-conductor of heat, is more likely to insure a good circulation than using exposed pipes in a cellar, as all possible should be done to lighten the upward column in the return-pipe. It is an improvement, also, to cover the flow-pipe up to the point where it turns horizontally.

NEW METHOD OF HEATING TWO BOILERS BY ONE WATER-BACK.

Q. Is THERE not some arrangement by which two boilers can be heated from one water-back?

A. Figure 179 illustrates a method of warming two boilers from a single water-back, each boiler being under a different pressure.

The arrangement has been devised to overcome the objection to and necessity for *two* water-backs in the same range, where water from a tank or cistern at the top of a house must be warmed to supply the upper stories, while water for kitchen and laundry purposes and the lower stories is obtained directly from the street supply in the usual manner.

The contrivance consists essentially of the high-pressure or "tank" boiler A, the low-pressure or "Croton" boiler B, and, in the absence of any other name, what may be called the *"heater,"* C; with, of course, a water-back of ample dimensions in the range.

There are three distinct circulations: (1) The warm water flowing from the back (which in this case is the low-pressure) passes

through the pipe *c* to the heater C, returning through the pipe *c'*; (2) The warm water in the outside chamber (*g*) of the heater C, passing through the pipe *d* into the boiler B, and returning to the heater through the pipe *d'*; (3) The water from the inner chamber

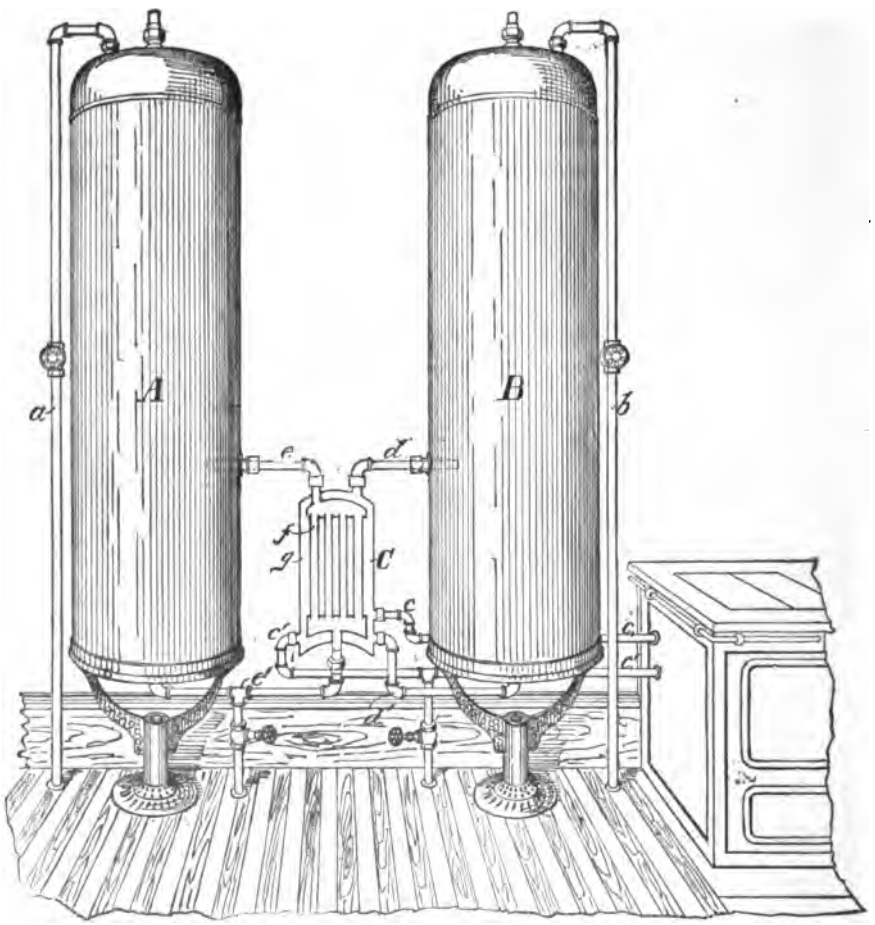


FIGURE 179.

or tubes (*f*) of the heater C passing through the pipe *e* into the boiler A, and returning to the inner chamber again through the pipe *c'*.

It will be seen by this that the *first* and *second* circulations are

low-pressure, and that the *third* is high or tank-pressure; but not so of necessity, as the tank-pressure may be used in the water-back, heater, and boiler B, transposing the order of the boilers; but the arrangement shown is, in the opinion of the inventor, the best, as by this order the tank may become empty, by neglect or otherwise, without danger to either boilers, or the tank-water may be shut off without drawing the fire.

The heater is seven inches in diameter by fourteen inches long, outside measurement, and is made of copper. The inner part (*f*) is a tubular heater, with connecting chambers at the ends. The water of the outer chamber is around and between the tubes, and imparts its heat to the water within the tubes. The tubes are three-quarters of an inch in diameter by ten inches long, and thirteen in number, and have been found by experiment to give equal temperatures to both boilers.

How much less surface in the inner part of the heater would give good results the inventor does not know, but he points out the fact that an excess of surface can have no other effect than to maintain an equable temperature between the boilers. He also points out that should the fire go down, leaving both boilers full of pretty hot water, and should the warm water in any one boiler be drawn away, exchanges of heat by circulation still go on between the boilers and the heater, warming the cold boiler, and, of course, cooling the warm one, but, nevertheless, giving a greater quantity of warm water from the boiler drawn on than could be gotten if it connected directly with its own water-back.

PLAN OF HORIZONTAL HOT-WATER BOILER.

COLONEL JAMES TUCKER, of Boston, furnished us with the plan, Figure 180, and description of the method he adopted in fitting up a horizontal boiler in a house near Boston.

The construction of the kitchen would not admit of the boiler being placed in the usual upright position; the sink and range occupied all the space between the two doors, there being no other available place to locate the sink, consequently the boiler was made to order and slung horizontally over the range, on two iron bands three inches by one-quarter of an inch, connected on top of boiler by bolts and ¾-inch rods run up through the floor timbers with nuts on top. The

water can be drawn off in the usual way and the boiler removed if necessary, the iron rods remaining in place. The cost of the iron rods and bands did not exceed two dollars more than the usual iron stand.

PLAN OF HORIZONTAL HOT-WATER BOILER.

A.—Main Supply to rhe Tank.
B.—Cold Supply to the Boiler.
C.—Hot-Water Circulation Pipe.
D.—Hot-Water Pipe with Open End over the Tank.
E.—Hot-Water Pipe to the Pantry-Sink.
F.—Cold-Water Pipe to the Pantry-Sink.
G.—Wash-Trays.
H.—Stop and Waste Cock.
I.—Branches to Fixtures on the Different Floors.
J.—Kitchen-Sink.
K.—Attachment to Hold Tank-Valve Open.

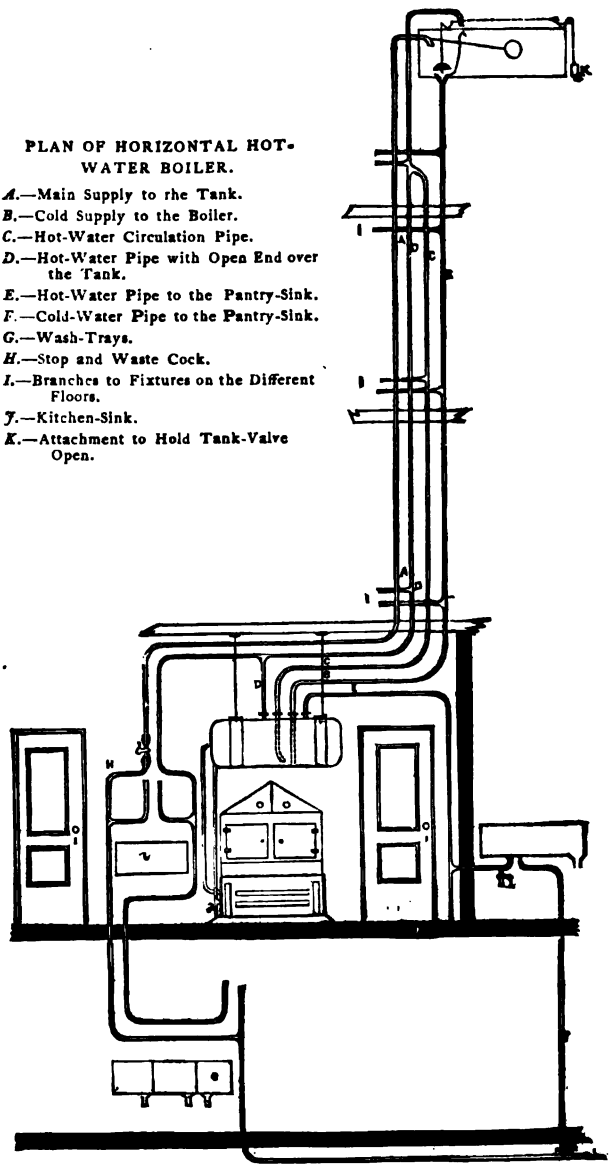


FIGURE 180.

CARVING-TABLES.

Q. I HAVE arranged several steam or carving tables to heat the water by running a pipe through a range, as shown in the inclosed

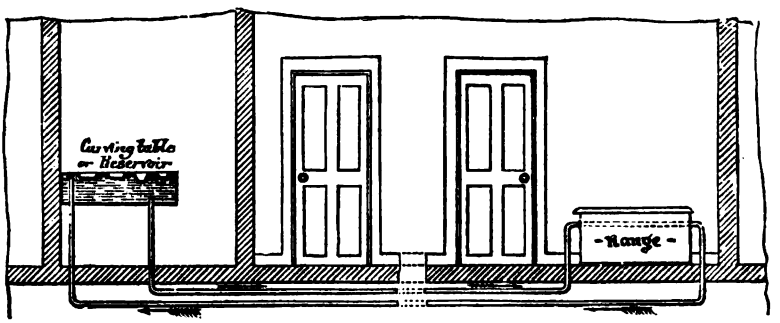


FIGURE 181.

sketch, but in every case the carving-table has been on the floor above, but in this house the table and range are on the same floor, and I cannot get more than two feet rise from range to table. Doors and

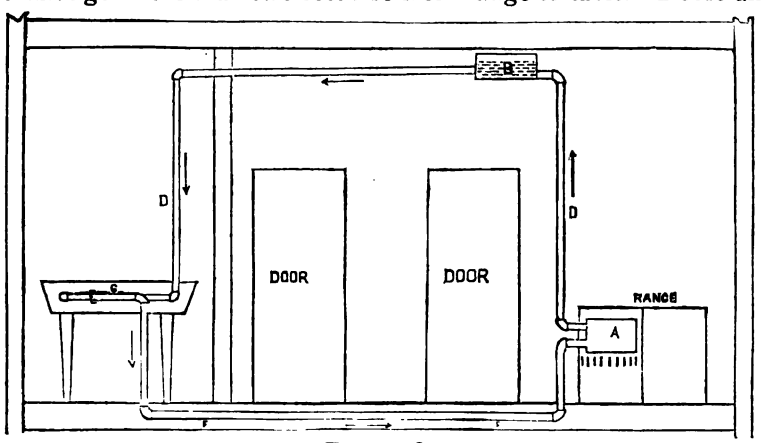


FIGURE 182.

windows prevent my running the pipe along the wall. Will it work as marked, or can you suggest a plan by which I could make it work?

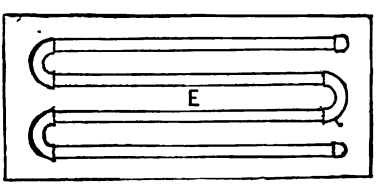


FIGURE 183.

A. There are several ways in which your object can be accomplished. The one we illustrate here is as simple as any. A is the water-back and B the expansion-tank, which may be either open

or closed. If an open tank is used, supply by ball-cock, and place overflow near the top of the tank. If a closed tank is used, have sufficient space in same to allow for the expansion of the water (not less than about 1-25 of the quantity of water in the apparatus). C is the carving-table, D the flow-pipe, E the coil in the table, shown also in plan, and F the return-pipe.

HOW TO HEAT A BATHING-POOL.

Q. WILL you please inform me how I can heat a bathing-pool, 84 feet long, containing about 72,000 gallons of water, the size of pipe that would be necessary, and how long you think it would take to heat? Also the size of boiler necessary.

A. If you wish to warm 72,000 gallons of water, say from 30° to 70° Fah., it will take the heat of about 2,160 pounds of steam to do it.

If you wish to do it in an hour from the time steam is turned on, it will be necessary that the boiler should have a heating-surface of not less than 800 square feet.

If noise is no object when warming the water, a 4-inch steam-pipe leading to a 4-inch header at the bottom of the tank, from which about 30 lengths of 1-inch pipe are run, open at the free ends, but reduced to the size of about a ¼-inch pipe, may be used to good advantage.

A more expensive apparatus, which may be made noiseless, is a somewhat similar coil of 1¼-inch pipe, but closed, the condensed water being pumped back to the boiler instead of being allowed to mix with the water in the pool, as in the first method. The surface for this coil will have to be a matter of experiment.

At the New York Natatorium, Fifth Avenue and Forty-fifth Street, the water is warmed by being circulated directly through the boiler, as in a hot-water apparatus, and is the system we would recommend, a boiler of about 300 feet of surface being sufficient, on the assumption that the time for first heating the water is no object, say three to five hours, after which a slow fire can be made so as to maintain the temperature required.

Of course, where the water from the boiler is discharged into the pool, care must be taken that the hot current cannot scald any one, a crib or some arrangement being required.

EXTENSIVE HOT WATER SUPPLY SYSTEMS.

KITCHEN AND HOT WATER SUPPLY IN THE RESIDENCE OF MR. W. K. VANDERBILT, NEW YORK.

THE following extract is taken from the articles on the plumbing in this house:

Figure 184 represents a portion of the kitchen, showing the range and boilers, most of the water-pipes, and the sink. The sketch was made before the hood over the range was in place, as it would have hidden the greater part of the boilers. The inside is plastered on a perforated lining of galvanized-iron separated from the outer shell of copper to prevent radiation of heat from the range and boilers into the room. The hood is very heavy and is supported from the floor-beams above by galvanized-iron hangers of an ornamental pattern. Hot air and odors from the range are removed into a chimney-flue through an opening partly seen behind the left-hand boiler.

The range has two fire-boxes, square in horizontal section, and each fire-box has two water-backs, so arranged that either fire-box will heat water for either boiler alone or both together. Each water-back is shaped like a short piece of angle-iron, lining two adjacent sides of the fire-box, while the two opposite sides are lined with the corresponding water-back, so that each fire-box is surrounded on all sides by water-backs.

There are two boilers, as will be seen, hung in a horizontal position over the range. That on the left, marked *a*, is designed to be supplied from the street-pressure, and the other, a_1, from the tanks in the top of the house. These boilers are made of very heavy copper, weighing about 360 pounds each, and are supported on brass "cradles" attached to the brass rods *b b*. It will be noticed that each boiler has four pipes, *c, c, c, c*, to the range. This is to provide for the heating of water for either boiler by one fire-box; one pair of each set of pipes crosses to the fire-box below the other boiler, or, in other words, each fire-box has a pair of pipes from each boiler. These pipes are of heavy brass, like all the water-pipes shown, and are one and a half inches in inside diameter. Each has a stop-cock just below the boiler, as shown at *d*, operated by wrench-handles, put on

only when occasion requires their use. The 1-inch pipe *e*, entering the extreme left-hand *c*-pipe (being the supply from the street-press-

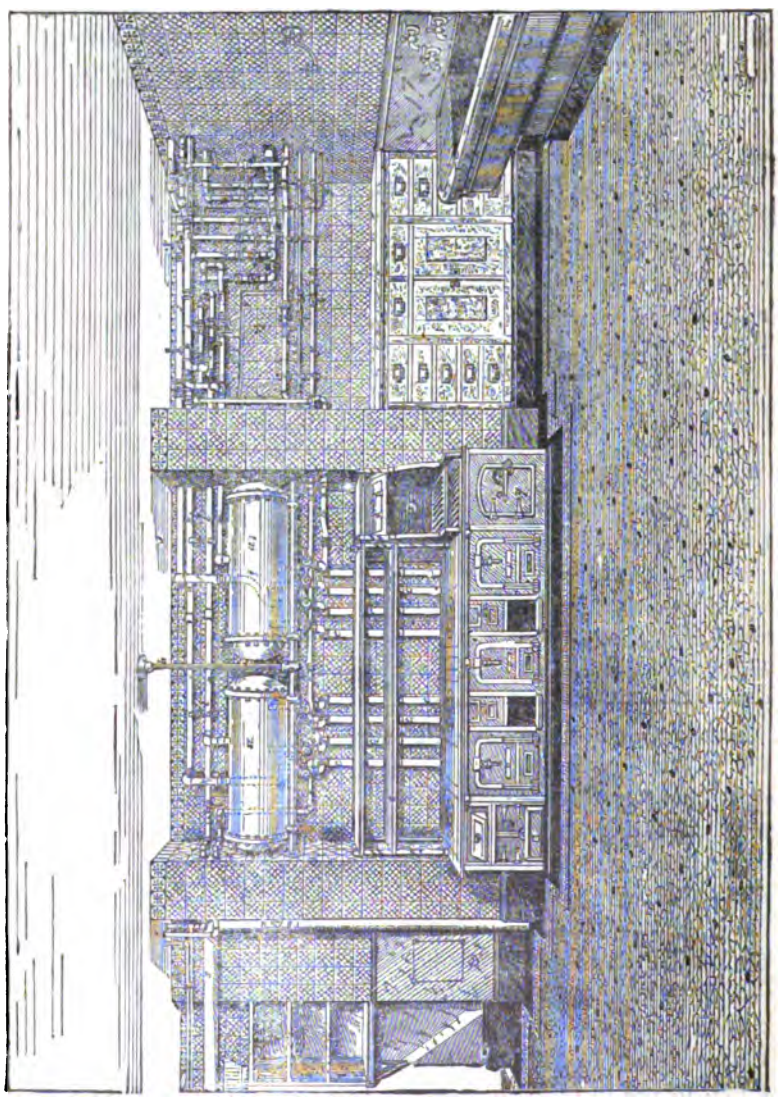


FIGURE 184.

ure boiler to one of the water-backs in the fire-box below it), is the return or circulation pipe from the plate-warmer in the butler's pantry, directly over the kitchen. The main circulation-pipe *f* (also 1-inch), for the street-pressure boiler, enters the third *c*-pipe from the left, which is the supply from the street-pressure boiler (on the left) to the right-hand fire-box. The 1-inch pipe *g* (the lowest of those on the right) is a continuation of the lower horizontal part of *f*, and is for emptying the street-pressure boiler. The 1¼-inch pipe *h*, coming to the extreme right-hand *c*-pipe, is the circulation for the tank-boiler, a_1. The 1-inch branch *i* (not shown as large as it is proportionally) is for emptying the tank-boiler. The 1½-inch pipe *j*, entering the right-hand boiler, is from the tanks, while *k* is from the street. It is two inches in diameter at its entrance, diminished to one and a half inches after the two 1-inch branches k_3 k_3 have been taken from it to other fixtures. It continues this size, in k_1, to the boiler *a*. The 1¼-inch pipe k_2 goes to fixtures in other rooms. The main hot-water supply *l*, from the street-pressure boiler, is 1½-inch, diminishing as it sends off branches, l_1, being 1¼-inch, l_2 1-inch, and l_3 (to the butler's pantry-sink) ½-inch. In like manner the several pipes marked *m*, m_1, and m_2 are the hot-water supplies from the tank-boiler, being of the following sizes, respectively: 1½-inch, 1¼-inch, and 1-inch. These supply-pipes from the tank-boiler go to all fixtures needing hot water above the first floor, which, with the basement, is supplied from the street-pressure system. This arrangement was necessary from the fact that the public supply is uncertain above the first floor in this house. Though it may never be necessary, an interchange of this system (so far as is possible) is provided through the 1¼-inch and 1½-inch pipes *n* and *o*, connecting the street supply-pipe *k* with the tank supply-pipe *j*. By opening the cock on *n* water is admitted from the street supply-pipe to the tank-boiler, and by opening that on *o* water from the tank supplies all street-pressure fixtures, check-valves *p p* on both *n* and *o* preventing the water from flowing the wrong way.

All the stop-cocks have removable handles. They are not kept on as shown in the illustration, but were put on, with the handles at right angles with the pipes, to show them more clearly. From each is a ⅜-inch waste-pipe to empty the part of the pipe beyond the cock when it is closed. These connect with the ¼-inch pipes *g g* (finally increased to ½-inch) which discharge the waste from all the cocks into the under-drainage.

In the extreme left of the view, the pipe *r* (of brass, 1-inch) is a safe-waste from a sink, and the large pipe *s* a steam-heating pipe, canvas-covered.

The range, as is evident from the illustration, is remarkably extensive. It was, of course, made specially for this place, and with great pains. A plate-warmer, *t*, of iron, stands on the back part. There are two fire-boxes, *u u*, as already intimated; three baking-ovens, *v v*; a roasting-oven, *w*; a broiler, *x*; and beneath it an ash-bin, *y*.

The room is very large, and finished in a very substantial and durable, but simple style. The floor is of small, irregular broken chips of white marble rolled in a dark brown cement and afterward rubbed smooth. Around this, next the walls, is a black border five inches wide, made of small (⅝-inch) squares of marble; inside of this is a narrower band (3-inch) of similar white marble blocks, and inside of this a single row of black squares. The walls, to the height of nearly four feet above the base-boards, which are of black marble, are finished in dove-colored marble capped by a border of black marble, and above that in white tiles having a simple blue pattern. All the projecting edges of the wall (as those of the piers at each end of the range) are covered by rounded strips of brass, fitted over the edges of both the intersecting faces of tile, and fastened with brass screws driven into wooden plugs inserted in holes drilled in the brick. All projecting face angles of tiled wall throughout the house are finished in the same way. There are several sets of white marble shelves in the angles of the wall, with backs of the same material, and under the windows, opposite the range, is a single shelf of marble, very large, with marble back and ends. It measures about two feet wide by twenty feet long and is two and a half inches thick. The sink shown on the right is cut from a single block of dove-colored marble.

In the butler's pantry, directly over a part of the kitchen, are two sinks of heavy white porcelain, each measuring about 18 x 30 inches, set in Italian marble slabs, with casings of cherry-wood. They have standing overflows, nickel-plated, with flaring tops to secure a more rapid escape of water. The supplies are ½-inch, and the waste 3-inch with 3-inch trap, from which is 2-inch vent. One sink has counter-cocks and the other "bibs" with long shanks—in both cases heavily nickel-plated and made specially for this place. Within a casing adjoining one of the sinks is a plate-warmer, consisting of a

coil of 1-inch brass pipe, through which circulates hot water from the street-pressure kitchen-boiler, having a direct return to the water-back, as already described in explanation of the illustration.

KITCHEN AND HOT WATER SUPPLY IN THE RESIDENCE OF MR. CORNELIUS VANDERBILT, NEW YORK.

THE following extract is from the description of the sanitary arrangements in the residence of Mr. Cornelius Vanderbilt, New York:

The kitchen in this house contains a large amount of plumbing-work. In it, or connected with it, are some features peculiar to this place, or at least such as we have not before described.

The sketch, Figure 185, shows the arrangement of the greater part of the work. One of the most striking peculiarities seen in it is the location of the range. Instead of being placed against the wall between brick piers, under the chimney or very near it, it stands out in the room two feet or more from the wall behind, and at a considerable further distance from the chimney, which is on the right hand beyond the end of the range.

Another novel feature is the method of supporting the horizontal boilers. They are usually suspended from the ceiling, but here they are supported from the floor, resting in nickel-plated iron frames of an ornamental pattern. The boilers—one for street and one for tank pressure service—are of heavy copper, with riveted heads. Each is connected with two water-backs, so arranged that both boilers may be heated from either of two fire-boxes, or either boiler alone heated from either fire-box. The upper boiler is supplied from the street-pressure, and furnishes hot water for all the baths, basins, and sinks below the third floor. The lower boiler is supplied from the tank, and furnishes hot water for fixtures above the third floor. Those on that floor may be supplied from either. The supply-pipe to the street-pressure boiler is connected with that to the tank-boiler by a pipe having in it a valve opening toward the latter, so that if the tank-supply should fail the tank-boiler will fill from the street-pressure; or, by a stop-cock on this connecting pipe, the tank-boiler may be shut off entirely and the street-supply only used. Vacuum-pipes are connected with the hot supplies from each boiler to prevent

any danger of collapse in case the supply fails. These join and enter the sediment-pipe below the stop-cock on it, thus furnishing an air-inlet if there should ever be need of one. A valve on each pipe above their junction, opening inward, prevents loss of water from either under normal conditions.

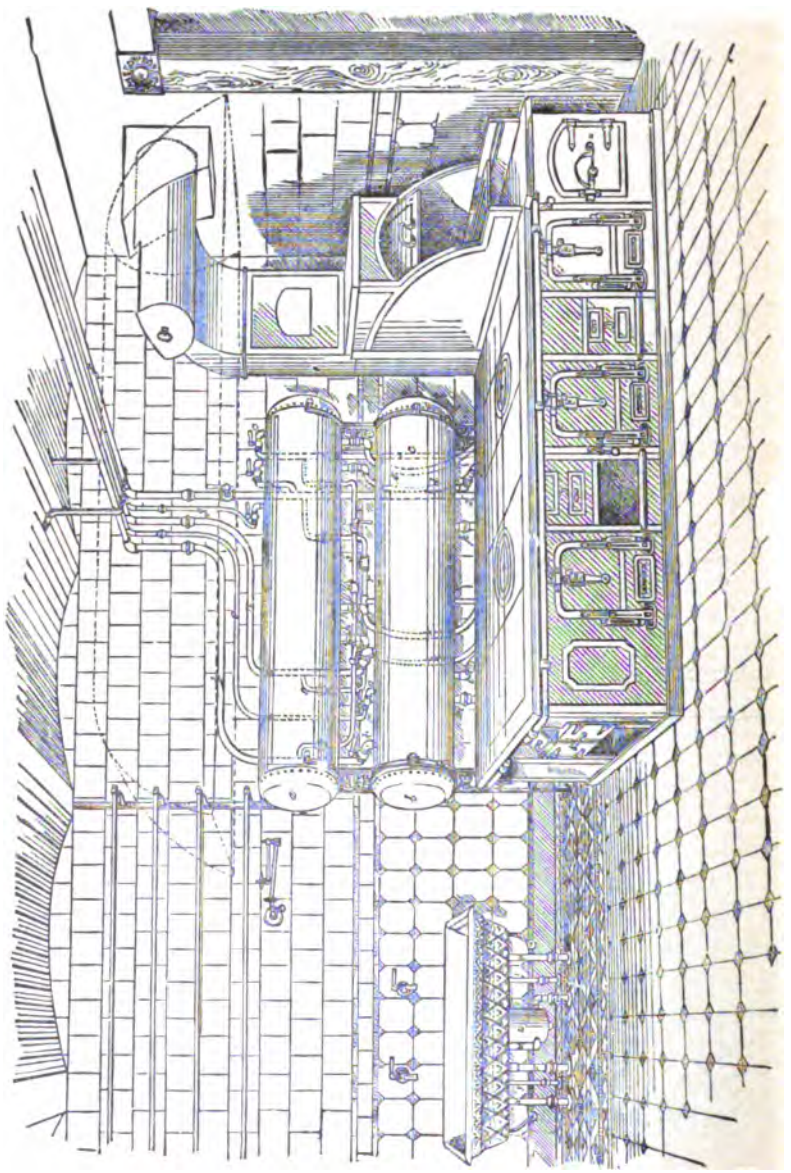


FIGURE 185.

The following is an explanation of the lettering on the sketch: *a*, the street-pressure boiler; *b*, the tank-pressure boiler, each about 150 gallons capacity; *c*, the supply to the street-pressure boiler, 1¼-inch, passing around through the outer divisions of three sink grease-traps before entering the boiler; *d* (1-inch), from the boiler *a* to a water-back in the right-hand fire-box; *e* (1¼-inch), return from the range to the boiler; *f* (1¼-inch), hot supply from the street-pressure boiler, passing both to the upper floors and to the cellar; *g* (¾-inch), return circulation to this boiler; *h* (1-inch), the cold-water connection from the same boiler with a water-back in the left-hand fire-box; and *i* (1¼-inch), the hot-water return to the boiler. The (1¼-inch) pipe *k* is the supply to the tank-boiler *b*; *l* (1-inch) is the cold-water connection of this boiler with the other water-back in the left-hand fire-box; *m* (1¼-inch), the hot-water return; *n* (1¼-inch), the supply from the tank-boiler going direct to the division-cock on the third floor, and *o* (¾-inch), the return circulation. The other water-back in the right-hand fire-box is connected with the same boiler by the pipes *p* (1-inch) and *q* (1¼-inch). The vacuum pipes *r r* (¾-inch) join and enter the sediment-pipes below their junction. The latter are behind the range and not seen; there is one for each boiler, being a ¾-inch branch from one of the two pipes leading from each boiler to the range. The combined sediment and vacuum pipe terminates over a sink in the cellar. The connection between the street and tank supplies, spoken of above, is marked *s*, and is 1-inch.

The remaining letters apply to the pipes under the enameled-iron sink at the left of the range; *t* is the entrance of the cold-water pipe (supplying boiler *a*) to the outer part of the grease-trap *u*, and *v* its exit; *w w* is the waste (2-inch), forming a deep trap, and *x* the air-pipe to prevent siphoning; *y* is the hot water-supply to the sink, and *z* the cold, both ½-inch.

In a corner of the room, in front of the range, is a deep pot-sink, of tinned and planished copper (not seen in the sketch). This has the same kind of grease-trap on the waste. This sink is so deep, and the bottom consequently so near the floor, that there was not room to put the grease-trap above it. Accordingly, a hole was made large enough for it through the brick and concrete floor, and lined with an iron casing or box. The boiler-supply water is passed around the grease-trap in this way: The main line runs along beneath the floor (suspended from the ceiling of the cellar) past the location of the trap above. Directly opposite the trap a stop-cock is placed on the

main line, and a branch, taken off on one side, passes through the trap and comes back into the main line on the other side of the stop-cock when the latter is closed. If it is open and those on the branches closed it flows straight past. It may be well to explain here, for the benefit of those who have not seen this grease-trap or a description of it, that the water is thus made to circulate around it (through an annular space entirely separated from the interior), for the purpose of cooling the collected grease and causing it to solidify. The supply to the boiler is chosen to effect this object, because not only is there no objection to thus slightly warming the water, but it is actually so much saving of heat.

All the pipes, with their frames, supports, and fasteners, are nickel-plated. The brass pipes are frequently bent in long curves, like lead, and sharp turns with elbows avoided as much as possible. The piping is all put together with frequent unions, so that it can be easily taken apart. It was all fitted in position while unplated, then taken down and put back after being plated.

Over the range is a very large copper hood for arresting and removing the odors and hot air. As this would have hidden much of the piping if shown in the sketch, it is only indicated in dotted lines. The outline is not strictly correct; the width is considerably greater, projecting in front of the range a foot or two. It is hung from the iron floor-beams overhead. The hot air and odors from cooking are carried off through an opening in one end of the hood into a rectangular duct surrounding the smoke-pipe.

A plate-warmer on the back of the range was left out entirely to avoid confusion in the sketch. Attached to that are several gas-burners to light the range. The gas-pipe comes up through the range into one of the rods supporting the shelves of the plate-warmer, and thence along behind the turned-down front edge of the upper shelf, and is thus entirely hidden.

KITCHEN AND HOT WATER SUPPLY IN THE RESIDENCE OF MR. HENRY G. MARQUAND, NEW YORK.

THE following extract, showing only the kitchen, is from the description of the plumbing in the residence of Mr. H. G. Marquand, New York:

The boilers A and B, Figure 186, are respectively the "Croton" and "tank" boilers.

The "Croton" water-pipe *m*, 1½ inches in diameter, is taken from the general cold system in the cellar through the floor at *m*, passing up and entering the boiler A at *m* on top. The "tank" water-pipe *k*, also 1½ inches in diameter, comes through the floor from the tank-main in the cellar, entering the boiler at the top. Between the "Croton" pipe *m* to the boiler A and the tank-pipe *k* to the boiler B is a ¾-inch pipe, shown by dotted lines, and furnished with a stop-valve and check-valve, *a'*. The object of this pipe is to allow water to pass from the Croton-pipe *m* into the tank-pipe *k*, thence to the tank-boiler, should the water-supply from the tank be interrupted or should the tank be run empty. The passage of the water from the tank-pipe to the Croton-pipe is, of course, prevented by the check-valve, which only opens upward and which is kept to its seat when water is in the tank by the greater pressure. The pipe *f* is where the hot water leaves the Croton-tank for low distribution. Upward from the boiler it extends into a header (*f*), composed of 1½-inch nipples and tees, from which the pipes f^2 extend to the different points of distribution, such as butler's pantry, billiard-room, servants' bath, and all points in basement and first floor, and to the "cut-offs" of the different risers to the second floor. In like manner the hot-water pipe *l* from the tank-boiler B extends into a *header*, l, from which the pipes l^1 either run to the fixtures on the third floor or to the "cut-offs" of the risers for the second floor. The pipe f^1 is the warm "Croton" supply to the kitchen-sink, and is stopped in the pipe at the *star*. The pipe m^1 is a branch of the pipe *m*, and is the cold Croton water-supply to the same sink, stopping at the same *star*, the pipes being connected in this manner above the sink for the sake of a symmetrical appearance. In like manner the pipe f^2 conveys warm water to the pantry-sink, the pipe m^2 being the cold supply, the *star* being the dividing point, as before.

The pipe *j* is the return-circulation pipe to the Croton boiler, while *l* performs the same functions for the high pressure circulation to the tank-boiler.

There are separate water-backs to each boiler, as plainly indicated in the illustration, the circulation-pipes being as shown. The pipe *p*, with its valves, shows the "draw-off" connections of both boilers.

All the pipes shown, except the waste-pipes and air-pipes of the

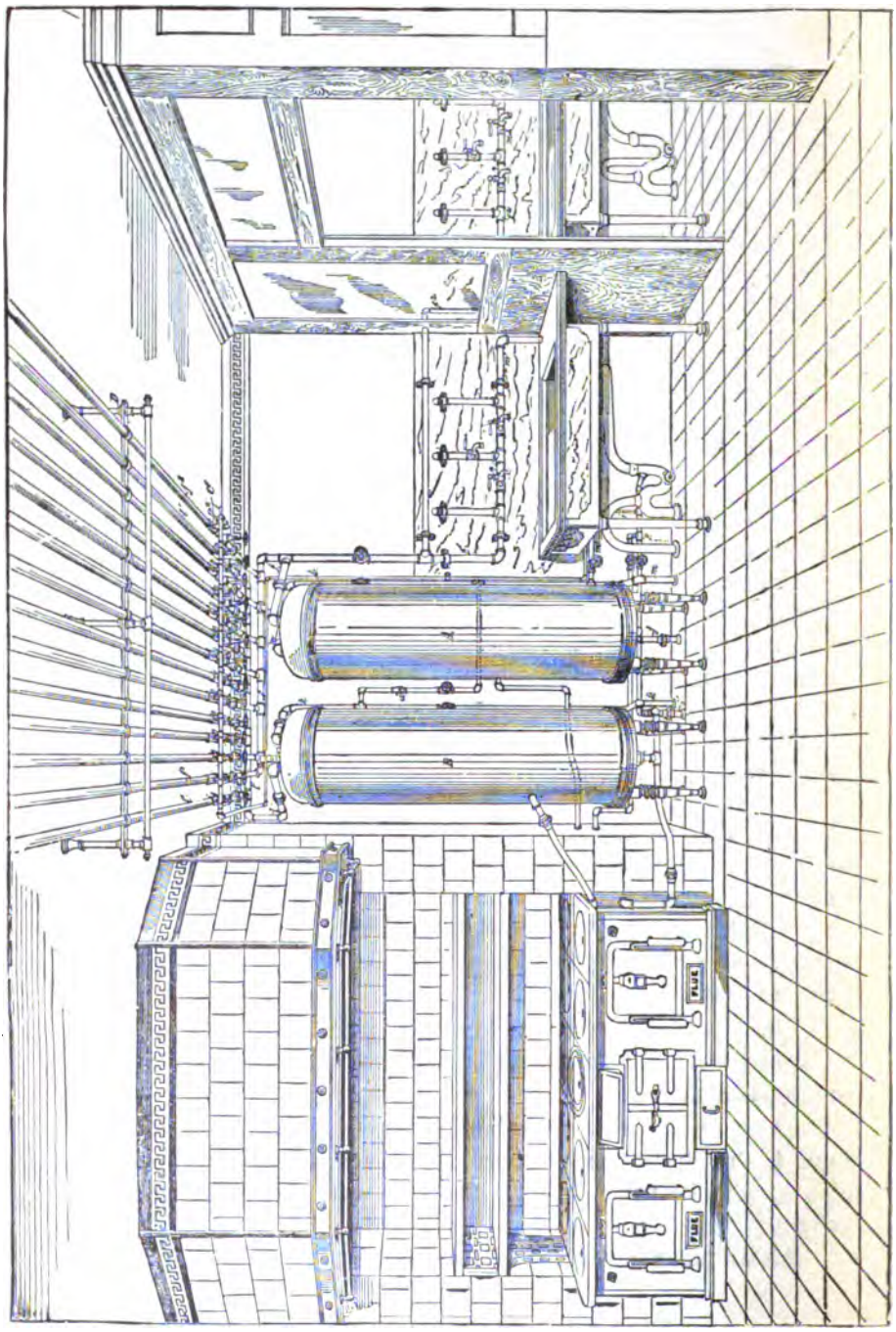


FIG. 136.

sinks, are seamless brass pipes, tinned, and the fittings are mostly special and of brass, the couplings being extra heavy with long threads, and all nickel-plated.

The sinks used are of white porcelain, supported in cast-brass frames, with turned legs. The slabs back of the sinks are of reddish-gray marble, against which the pipes are fastened. The arrangement of the traps and air-pipes is shown and all plainly, though tastefully, "soiled."

Under the hood over the range is a large register opening into a flue parallel with the range-chimney flue, which latter warms it. This flue is 12"x16" in its cross-section. The hood is lined inside and out with very light-tinted tiles, as are all the walls of the kitchen. The frame and rail under the lower edge of the hood are of brass, and the arrangement for connecting the range with its chimney-flues is such as to show no pipe.

The kitchen-floor is of encaustic tiles of selected designs, the colors being neutral.

KITCHEN AND HOT WATER SUPPLY IN THE RESIDENCE OF MR. A. J. WHITE.

FIGURE 187 shows another arrangement of a kitchen, and is in use in the residence of Mr. A. J. White, Fifth Avenue, New York City.

The kitchen is situated in a bay fronting on Sixty-sixth Street, the view showing three sides of an octagonal room, and illustrating an arrangement of *two* boilers—one on each side of the range—each being warmed by a separate water-back; the one on the *right* being the "Croton" or low-pressure service boiler, while the other is the "tank" or high-service boiler. The pipes are all of lead and very heavy, and the "back-air" pipe from the sink-trap is carried upward after entering the wall to the right of the sink. The "Croton," or street-supply, is shown coming through the floor just back of the sink-trap. From there it may be traced under the boiler and up at the side, entering at the centre "spud" of the boiler, and also continuing into the ceiling, it being the centre pipe of the three. To the

right of it the hot-water pipe leaves the boiler and branches up and down, the downward pipe being for the sink-faucet. The pipe which is the left of the three which here enter the ceiling is the return hot-water or "circulation-pipe." Its course can be traced to its junction, with the hot water entering the back, beyond which point it joins the

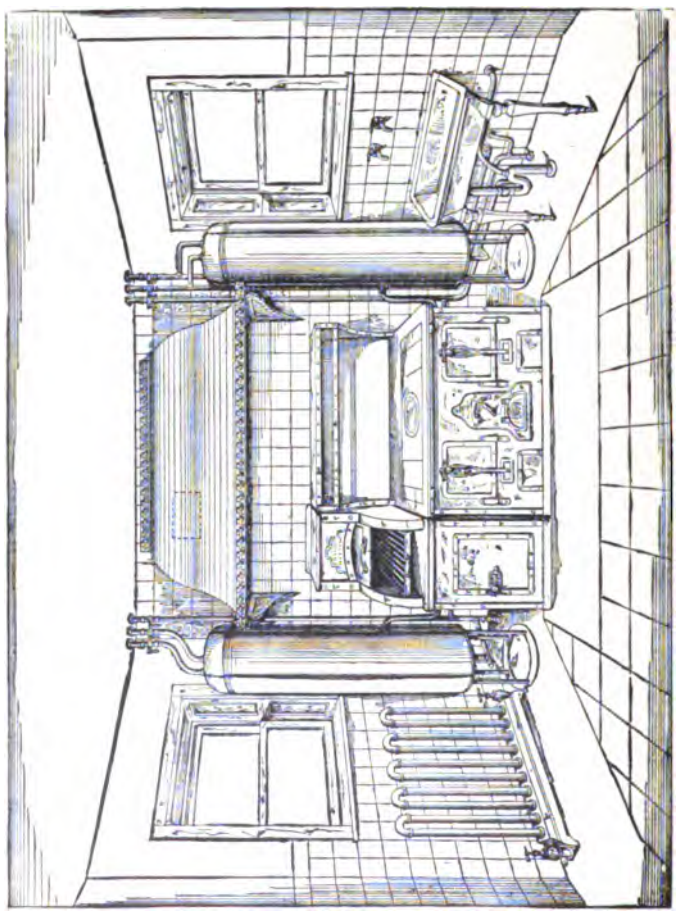


FIGURE 187.

boiler, and continues to become the "draw-off" or sediment-pipe. On the left of the picture is the high-service or "tank-boiler." The pipe to the extreme left conveys the hot water from the boiler; the one in the centre is the cold-water supply from the tank, and the one on the right the circulation-pipe.

HOT WATER SUPPLY IN AN OFFICE BUILDING.

FROM the article describing the plumbing of the Duncan Office Building, in New York, we take the following, which refers to the hot-water supply:

The former supply of water to the building (which has been considerably increased in size in its reconstruction) was through a 1½-inch pipe from the low-pressure main in Pine Street. This connection remains, and supplies the fixtures in the cellar. All other fixtures are supplied from a new 3-inch pipe from the high-pressure main in Nassau Street—the basement-floor being supplied by the street-pressure direct, and the upper floors from a tank on the roof. Each supply has its own meter, and the two are connected so that either may take the place of the other in case one fails.

The water-pipe is all of galvanized-iron, except in exposed places above the cellar, as the connections with water-closet cisterns, where it is of brass, nickel-plated. All draw-cocks at basins and sinks are self-closing. Besides the fixtures mentioned in the first article are two water-closets, a basin, and two urinals in the basement. These urinals are flushed from a separate cistern; a chain in each stall is connected with the same valve, so that both urinals are flushed together whenever either chain is pulled. This arrangement is expected to secure a more frequent flushing than by the more common method of placing a stop-cock on the pipe to each urinal.

The accompanying drawing, Figure 188, represents the hot-water reservoir or boiler and connecting-pipes in the engineer's room in the cellar. On the right hand are seen the indicators showing the height of the water in the two iron tanks on the roof; the larger of these, having a capacity of about 4,500 gallons, supplies all the fixtures above the basement, except those in the janitor's apartments on the top floor, which are supplied from the smaller tank, which holds about 2,000 gallons. The whole supply of the larger tank is brought to the cellar by the 2-inch pipe *a*; thence the greater portion is taken by the 2-inch pipe *b*, to supply the line of water-closets, urinals, and slop-sinks, described in a preceding article. Other fixtures in different parts of the building are supplied by the 1-inch pipes *c c*. One of these connected with *m*, supplies basins in the rear, which may also be supplied direct from the street, when the pressure is sufficient, through the pipe *l*, which supplies the sink shown. The 2-inch pipe *d* (reduced to 1½-inch at the turn behind the sink) supplies the

boiler; at the junction of the horizontal and vertical parts of *d* a 1½-inch pipe, *e*, is taken to the drain-pipe below the sink for emptying the boiler. The tank may be emptied through *d'* into the same drain.

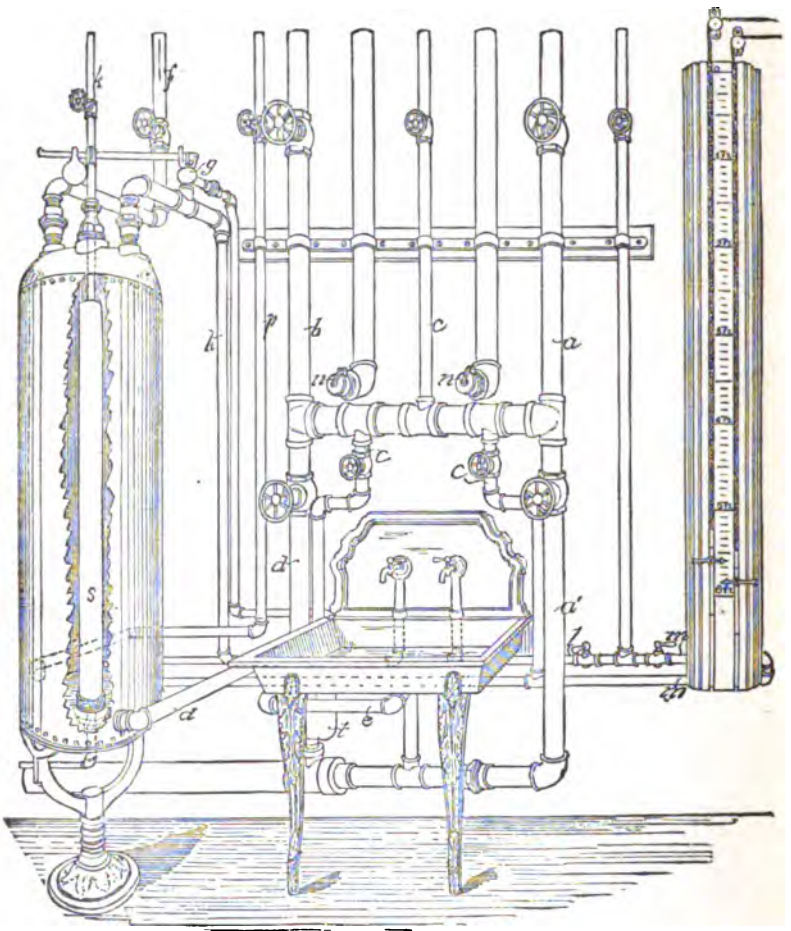


FIGURE 188.

The water in the boiler shown (which supplies the slop-sinks on all the floors) is heated by steam passing through the 2-inch pipe *s* in the centre. The arrangement is essentially the same as that adopted by the same plumber in the Mills Building, except that the connections have been somewhat simplified. The essential peculiarity is the

provision for the expansion of the pipe inside the boiler. This is accomplished by passing the steam-pipe *k* (½-inch) through a stuffing-box on the top of the boiler, the expansion being taken up by the spring of the horizontal part (not shown) of the same pipe. This small pipe is connected with the larger about six inches below the top of the boiler, by being threaded into an annular disk or circular plate welded into the top of the 2-inch pipe. At the bottom the return steam-pipe is threaded into a hollow nut cast on the bottom of a cap-shaped fitting, which screws into the bottom of the boiler, and into which the 2-inch pipe is threaded. By this arrangement it is claimed that the whole head of steam can be turned on without producing any noise in the boiler, and that the water may be heated very rapidly. It is said to have worked very satisfactorily in the Mills Building during the year it has been in use.

The main hot-water supply from the boiler is 1½-inch (marked *f*); another pipe of the same size has on it a safety-valve, *g*, with a ¾-inch blow-off pipe to the sink; this 1½-inch pipe is then reduced to ¾-inch to supply the sink. The circulation-pipe *p* (¾-inch) enters the boiler on the back side, as indicated in dotted lines. The sink-trap is marked *t*. The safe-waste pipes are collected into two 2-inch pipes, *n n*, from opposite portions of the building, which end over the sink as shown, having flap-valves on the ends. These main lines are continued through the roof, there increased to three inches in diameter for ventilation. As they are closed at the bottom, the circulation is between the openings under the fixtures and the outer air. These pipes, like the water-supply pipes, are of galvanized-iron.

KITCHEN AND HOT WATER SUPPLY IN THE RESIDENCE OF MR. SIDNEY WEBSTER.

Our illustration, Figure 189, shows the novel arrangement of high and low pressure boilers in the residence of Mr. Sidney Webster, at 245 East Seventeenth Street, New York. The problem in this case was to utilize the limited space between the door and window for the kitchen-range and boiler paraphernalia. As the length of the space was not sufficient for the usual order of "double boiler" (one within the other), the arrangement shown was devised in

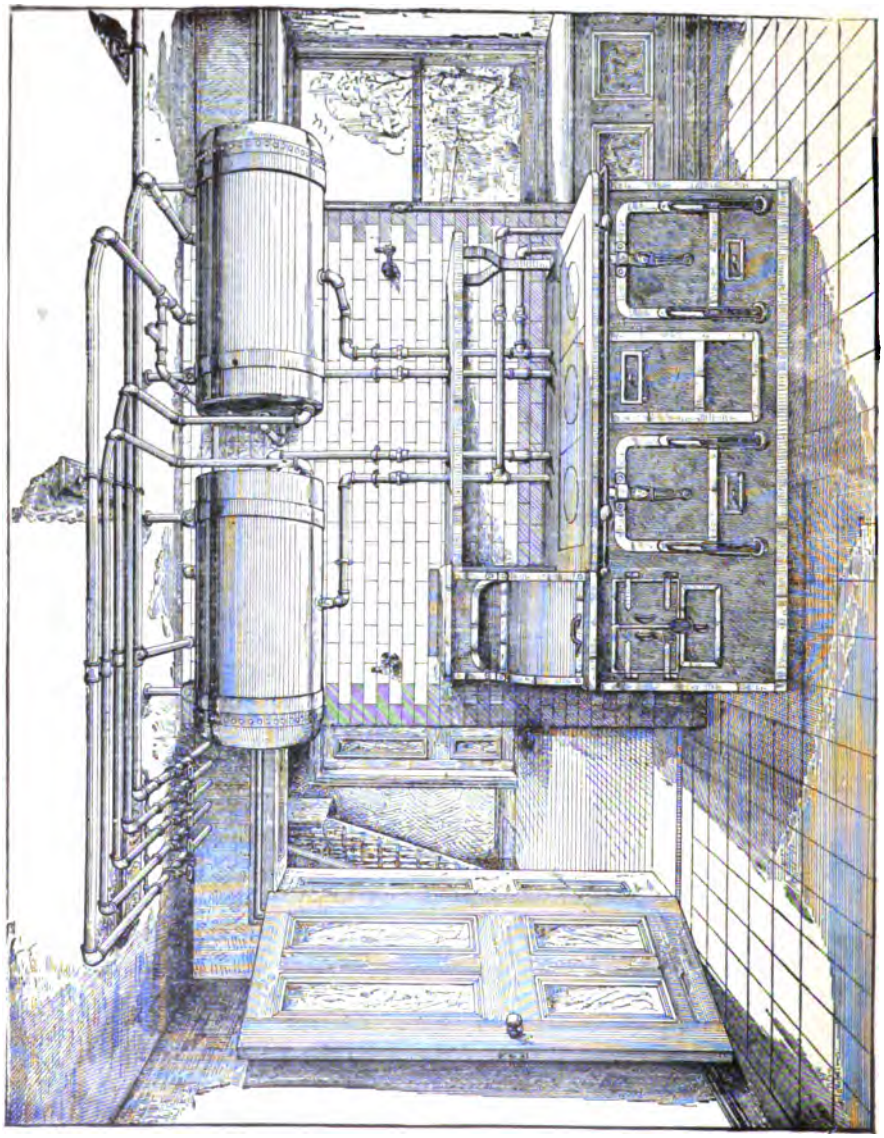


FIGURE 189.

preference to placing the boilers at a distance from the water-backs, whereby the question of circulation between the backs and the boilers might be jeopardized by carrying the flow-pipes above windows and door, and the return pipes underneath the floor.

Little can be said of the arrangement that is not apparent to the plumber in our very accurate drawing of the kitchen, but of the materials used and their sizes we will say a few words. The boilers are 48-ounce copper, each being forty-two inches long by twenty-one inches in diameter. They are encircled by copper bands, which secure them to vertical hangers, which enter the floor-beams, with

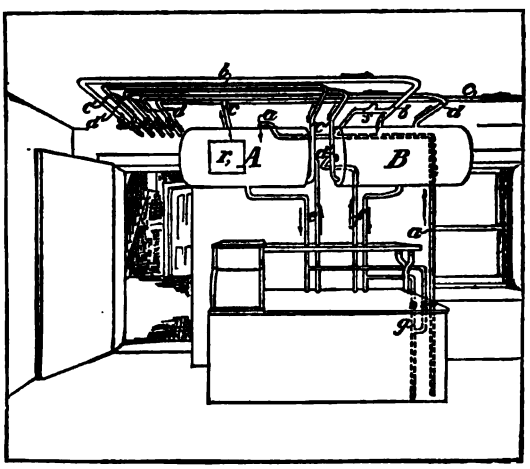


FIGURE 190.

large iron washers on top. The boiler A, Figure 190, is the low-pressure or "Croton" boiler, the other boiler (B) being the tank-boiler. The "Croton" or street-pressure pipe comes through the floor at the right of the range, and is supplied with a check-valve at *a* in the diagram, thence runs behind the boilers, as shown by the dotted lines, connecting directly with the low-pressure boiler at *a*, and with the high-pressure boiler through the pipe and check-valve *s*, which connects with the tank or high-pressure supply-pipe *b* close to where it enters its boiler. The object of the connection *s*, which is well known to plumbers, is to provide an auxiliary supply to the high-pressure boiler should the tank in the top of the house be empty through any cause, at which time the low-pressure will press through the check-valve and supply the boiler.

Two water-backs are used, the pipes *e* forming the primary circulation for the low-pressure boiler, and the pipes *f* performing the same function for the other. The pipe *C* is the *warm* low-pressure supply, which goes to the lower stories—first and the basement—the pipe C′ being the return circulation from the same. The pipe *d* is the *warm* high-pressure pipe supplying the upper stories, *d′* being the return circulation for the same. The pipe used is bright seamless brass, with cast-brass elbows and fittings.

Behind the boiler A is a ventilator-register of one and one-half square feet area, and opening into a chimney parallel with the range-chimney. The chimney-breast, which forms the background to the range and boilers, is of white glazed brick, quoined with glazed chocolate-colored bricks. The floor is of encaustic tiles in warm colors, and, taken altogether, the kitchen is very complete.

PLUMBING AND WATER-SUPPLY IN THE RESIDENCE OF MR. H. H. COOK.

THE following extracts are references to features connected with the hot and cold water-supply in the residence of Mr. H. H. Cook, of New York:

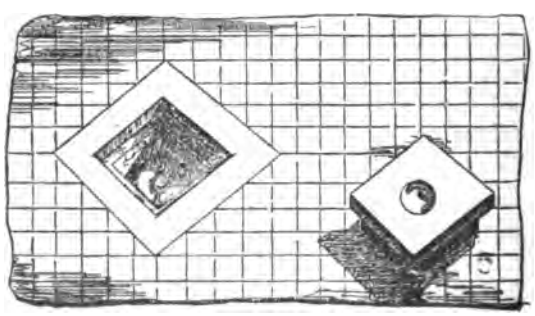


FIGURE 191.

Figure 191 is a detail of the means provided to reach the hand-holes of the traps of the rain-water leaders and hand-holes of other traps beneath the basement-floors. The rain-water leaders are brought into the house-drains in the positions intended to be the fittest for the flushing of all parts of the drains. There are two fresh-

air inlets, one in the outer wall of the Fifth Avenue area and the other in the area at Seventy-eighth Street. The sewers at these points are each six inches in diameter and the air-inlets five inches. All the house-drains and sewer-pipes, as well as such back-air pipes as are not of wrought-iron, are of extra heavy cast-iron. The heads of all the rising lines, as well as the back-air lines, are run alongside the roof-rafters to one point near the apex, where they are all con-

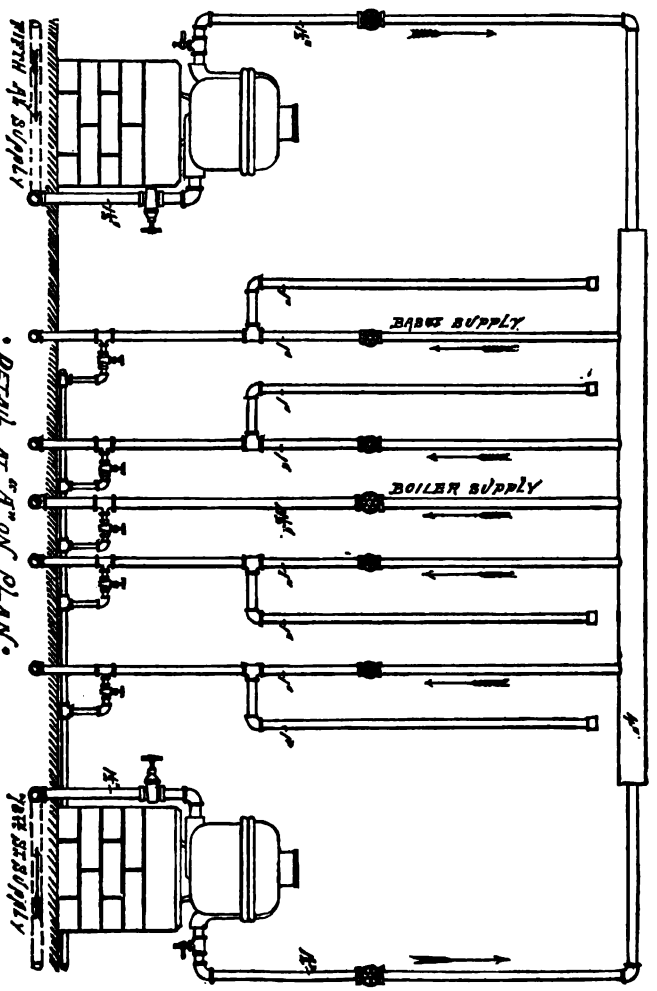


FIGURE 192.

nected into a copper hood of large area, whose opening to the outer air is turned downward.

The water-supply is taken from both the Fifth Avenue main and from that on Seventy-eighth Street. The object of this is to be able to take water from either street should the water in the mains of one of the streets be shut off. The pipe from each source of supply, after passing the service-cock, is one and a half inches internal diameter, and is AAA lead as far as the position marked A on the plan. Here the different services pass through their respective meters, the mode of distribution from this point being shown by Figure 192, which is a detail at A on the plan.

The water, after passing the meter that may be in use at the time, passes to a 4-inch brass header, as shown; thence it is distributed downward, through brass pipes, to get it underground once more, to join with lead pipes of the same diameters, for distribution to the principal parts of the house; one of the objects of putting it underground being to keep it at a lower *mean temperature* than could be obtained by running it on the ceilings through the basement.

The order of the pipes in the detail corresponds to the order in the plan, and may be traced to their point of delivery thereon. The centre pipe (one and a half inches) is for the main kitchen boiler-supply only. The basement-supply, as well as supplying water to the basement fixtures, furnishes a "Riker" gas-pump with water, to be forced to a tank in the top of the house at times when it will not rise there, for a high-pressure or tank supply. The other three pipes run to the principal divisions of the house, to supply the fixtures with cold "Croton" water as high as it will rise. Air-chambers are used on these pipes near the stop-valves in the position shown, their object being to prevent water-hammer at these ends of the pipes as is supposed likely to be caused by the reaction of the flow and column when suddenly checked, although there are air-chambers at the heads of the lines and ends of the principal branches.

The cold "Croton" supply is carried as high as the third floor fixtures, which it reaches at nearly all times, the pressure in the night being sufficient to fill the tank in the attic without pumping.

The cold tank-supply for the second, third, and fourth floors is carried from the tank downward to the basement, thence it is distributed and run to the different rising-line recesses, up which the cold and hot supplies are also carried to the lines of fixtures.

Figure 193 shows the hot-water distribution from both the street-pressure and tank-pressure boilers, commonly known as "Croton" boiler and "tank-boiler." These pipes are all carried just beneath the basement-ceiling on specially contrived hangers, and may be seen in the kitchen sketch, Figure 194. Figure 193 is the facsimile of a sketch made before the work was commenced, for the purpose of illustrating the principle to be followed by the workmen, and a comparison of the same with the finished work as shown in the kitchen (which is drawn from a photograph) will go to show how closely the original plan was carried out.

A double boiler is used, as shown in the diagram, the high-pressure or tank-boiler being inside the low-pressure or street-supply boiler, from which it receives heat in the usual manner. To a plumber it is not necessary to analyze the diagram, but for other readers who take a general interest we will outline the course of the water through the different pipes. The "street-supply" in diagram Figure 193 is the continuation of the "boiler-supply" in Figure 192, and is the (cold) street-supply to the low-pressure or outer boiler. It enters the boiler at the upper end, the water being carried down within it through a supply-tube. A branch of the street-supply is also carried to the inside or tank-boiler, but does not enter it direct, connecting with the tank-supply at the nearest point. The object of this connection is to insure the filling of the inside boiler with water from the street service, should the tank become empty from any cause. To prevent the tank-water from running backward through this connection the *check-valve* shown is provided, which valve will open upward and let the water pass when the pressure in the tank-pipe is less than in the street-pipes. A check-valve is also used in the street-supply to the outer boiler, to prevent the emptying of this boiler through an empty main should the latter be drawn out. The two stub-pipes shown at the left are the pipes which maintain the primary circulation between the outer boiler and the water-back of the range. The second circulation is through the "Croton hot" main pipe (see diagram) from the top of the outer boiler to the different branches, and the lines of fixtures to a point just below the "cut-off" in a line.

From this point it returns through the "Croton circulation" to enter the water-back and boiler again, as may be seen by tracing downward in the direction of the arrows. The third calculation is through the "tank hot" main, whose branches are carried to the

higher stories, from which the "tank circulation" returns from a point above the "cut-off," and enters the inner boiler again by passing through the bottom of the outer one, as known.

Figure 193 shows the interior of the kitchen. The walls and ceiling are white marble slabs, about four feet square, set with plaster of Paris, and held in position with brass rosettes, which form heads or nuts to tap-bolts which fasten with the iron joists and to expansion-bolts in the walls. The floor is of small white ceramic tiles, laid in cement upon a concrete bottom, as before mentioned.

Between the boiler and the range, and also under the sink, will be noticed positions in the floor where hand or peep hole covers to the house-drain are placed, such as are shown in detail in Figure 191. The sink is of very heavy white earthenware, with the back supported on a marble cleat, and the front resting on nickel-plated brass legs. Otherwise it is as plain as possible, with no place for lodgment of dirt. All the pipes shown are seamless

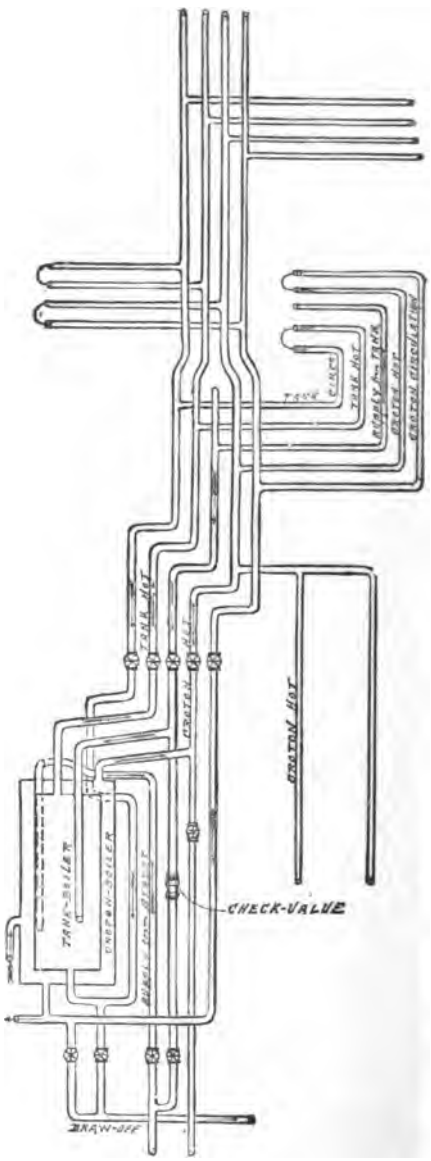


FIGURE 193.

brass and tinned, with nickel-plated fittings, valves, and hangers.

Under the hood of the range are two vent-registers, aggregating four square feet of area in the clear. They open into two chimneys, 12″ x 20″ each, which run parallel with and at each side of the range-chimney, which is of cast-iron, that the latter may communicate some of its heat to them.

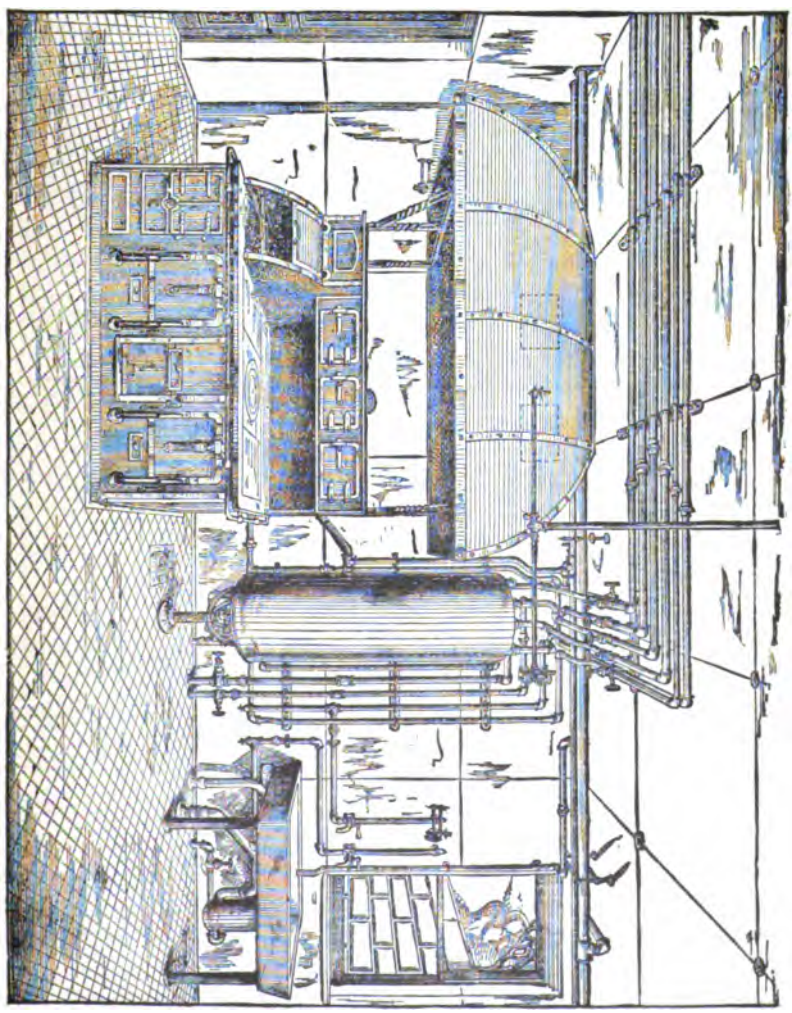


FIGURE 194.

One point worthy of special mention is the warming of a plate-closet in the butler's pantry by a branch from the primary or water-back circulation. It will be noticed that between the hood of the range and the boiler are two pipes, one starting from a *tee* close to the side of the boiler and the other returning into the circulation-pipe as it flows backward to the water-back. These pipes are the "flow" and "return" from a hot-water coil of about thirty feet lineal of ¾-inch pipe which is placed within the plate-closet. It was the intention of the master plumber to take the flow-pipe from the head of the boiler instead of from the primary circulation-pipes; but fearing that should any considerable quantity of water be drawn from the boiler it would cool the coil also, he changed it to the *tee* in the pipe, as shown, in which position it warms the coil shortly after the fire is started and before the boiler is very warm, giving a constant temperature of about 180° at the coil.

THE CONSTRUCTION OF TURKISH AND RUSSIAN BATHS.

THE following is a description of a Turkish bath establishment in New York:

The buildings are 165 feet deep, by 53 feet front, the principal floor and basement being devoted to bath purposes. The principal floor is reached from the street by a flight of stone steps; the level of the basement-floor, where the baths proper are, being two or three feet below the sidewalk.

"The baths" consist of Turco-Russian, Russian, and Turkish, with sitz-bath, needle-baths, douche, and warm and cold showers in the different departments. Figure 195 is a section through the Turco-Russian and Russian, and Figure 196 is a section on the line A B through the Turkish.

The Turco-Russian chamber is a seasoning-room, in which the temperature is kept at 118° to 120° Fahr., and is hot air laden with moisture to the point of saturation. It is warmed by direct radiation; the steam-coils (C) being placed under the marble terraces at the sides, as shown. Two circulations of the air are established; one, which may be called a local circulation, is the revolution of the air of the chamber in through the large register *a* to the coils to be warmed, returning again to the room through the small round register *b*. The other circulation is for the renewal of the air, and

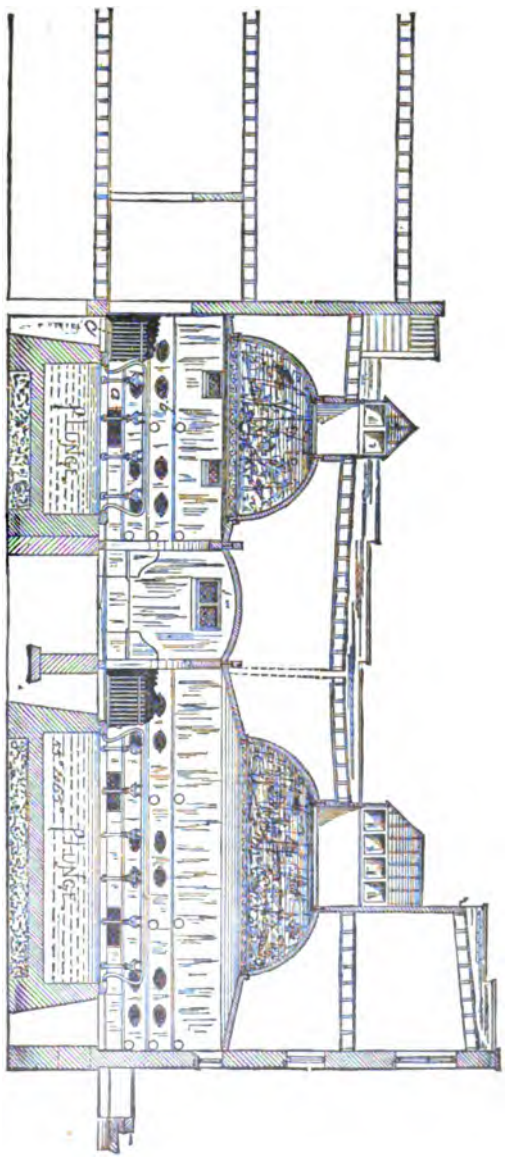


FIGURE 195.

is in at the arrow under the terrace, where it comes in contact with a coil, and diffusing with the air under the terrace, escapes with it. At the same time a portion of the air which has been through the chamber and which enters the terrace at *a* escapes through the vent-flues V V.

The Russian bath is similarly arranged with regard to the "local circulation"—*i. e.*, the warming circulation—the coils being under the terrace, with the exception of the circulation for the change of air. The inlets are Z-shaped openings through the walls under the windows, and shown by the arrows, the vents or air-outlets being at the floors under the terraces, and escaping through the flues in the walls marked V V V V. The air here is laden with all the moisture that can be held in suspension at a temperature of 120°, a supply being constantly kept up by an escaping steam-jet within the terrace. The amount of steam-pipe under the terraces in these two chambers could not be obtained with any accuracy, as Dr. Ryan was his own engineer in the matter, and had added surface in many sections until he obtained the desired heat necessary to maintain the temperature when moving air as fast as his flues would remove it.

In the Turkish bath the temperature varies from 135° to 140° Fahr., and is dry heat. The warming is by direct radiation, exposed in the rooms, the quantity of 1-inch steam-pipe being 4,500 feet, lineal. Air enters through the radiators from the outside, and is drawn off through the vent flues V V, high up in the fire-place chimney, and a large register over the plunge, near the apex of the roof. In addition to the vent-flues skylights above the domes over the plunges can be opened when required. The walls are made double and the windows small, to prevent an unnecessary loss of heat.

The plunge-baths, 7 x 12 feet and 7 x 22 feet are supplied with Croton water and the large plunge of the Turkish bath from an artesian well. The method of renewing the water is to draw them off entirely every night and sponge them out, then fill them with fresh water, and let a comparatively small stream flow through them all day, the surplus running off through an overflow in the manner usual to plumbing fixtures. The temperature in the mineral-water plunge is thus maintained at 55° to 60° Fahr.

There are five tanks of 11,000 gallons capacity for the storage of Croton and artesian well water, and one tank 4 x 6 x 9 feet for

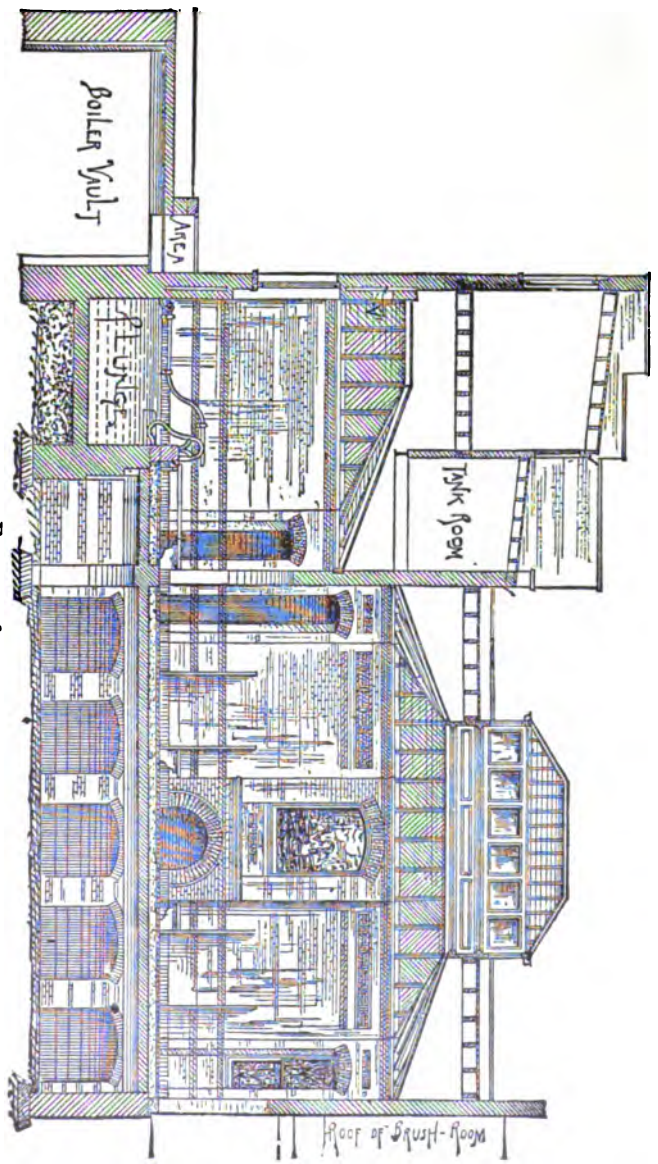


FIGURE 196.

warm water to guard against an interruption in the supply from temporary causes.

Croton water is supplied to the building through a 2-inch pipe, with a meter, for the boilers and all purposes for which the artesian water cannot be used. The capacity for pumping artesian water is 240 gallons per minute, and a little less than 100,000 gallons is used in the 24 hours.

A prominent feature of the appointments is the "needle-bath," shown in Figure 197. It is all brass pipe, nickel-plated, with ornamental fittings. The horizontal arms are perforated with fine openings, to discharge a fine spray on the body of the bather. The central vertical pipe is connected with the warm and cold pipes K and N by the cocks A and B, which admit of variable degrees of temperature in the spray. The cocks C and H regulate the shower and control the supply in the same manner. F and G are the liver-sprays, being metallic pads perforated with minute openings, one being cold and the other tepid, and are controlled by the cocks D and E. A douche, L, is in the floor-slab, and is regulated by the cocks J and I.

The floors and walls in the vapor-baths are marble, and the ceilings and domes wood, painted and ornamented in oil. Around the domes slight condensation takes place, and would drop on the bathers were it not that an internal eaves-trough, that is nicely arranged to harmonize with the finish, carried this drip to a convenient down pipe.

Steam is supplied to the building by a boiler 16 feet long by 5 feet 6 inches diameter, with fifty 4-inch tubes, and the water of condensation is returned by any "Albany" trap. A smaller boiler, 14 feet by 48 inches diameter, is kept in reserve.

The principal or parlor floor of the building is for the use of the guests after bathing and resting, preparatory to going into the street. The reception-room is 24 x 60 feet, beyond which is a parlor 22 x 21, in the rear of which is a billiard-room 24 x 30. Adjoining the billiar-room is a café 16 x 24.

For those not acquainted with the routine of baths we append the following short description: The bather pays at one desk, passes to another and leaves his valuables, is assigned a dressing-room, and after disrobing is shown to the Turco-Russian bath, a seasoning-chamber in which all bathers remain awhile before entering either Russian or Turkish baths. When his skin is slightly moist, he

is led to a couch and soaped, scrubbed, and rinsed off with a tepid shower, when he passes to either of the baths. The rest of that time in the bath (which may vary from twenty to forty-five minutes, according to his strength or the doctor's orders) he spends in alternately sweating and showering, finally finishing with a cold plunge

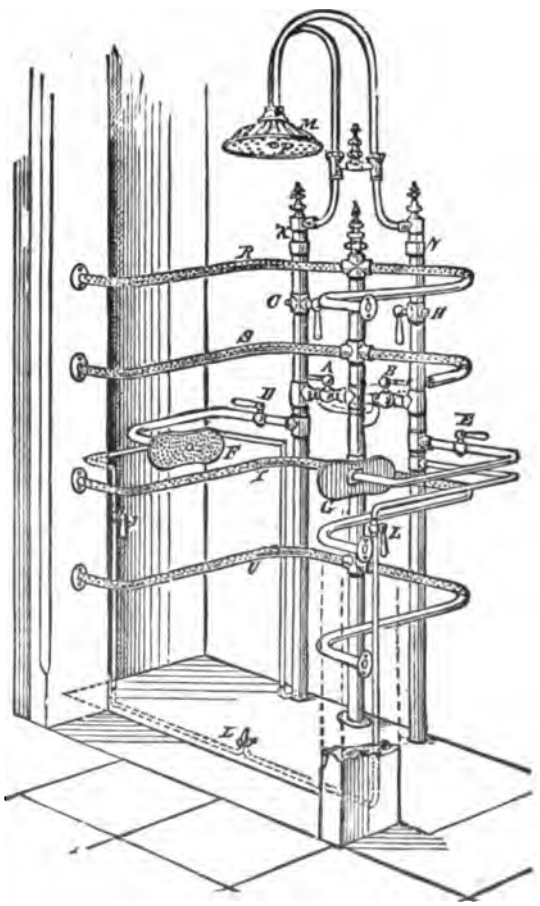


FIGURE 197.

or shower bath. He is then passed into the cooling room and dried with towels, from thence to the rubbing-room, where he is rubbed and manipulated with the bare hand of the attendant until his body is all aglow. He is then placed on a couch in another chamber with a sheet spread over him, and there takes his ease until he feels like resuming his clothing.

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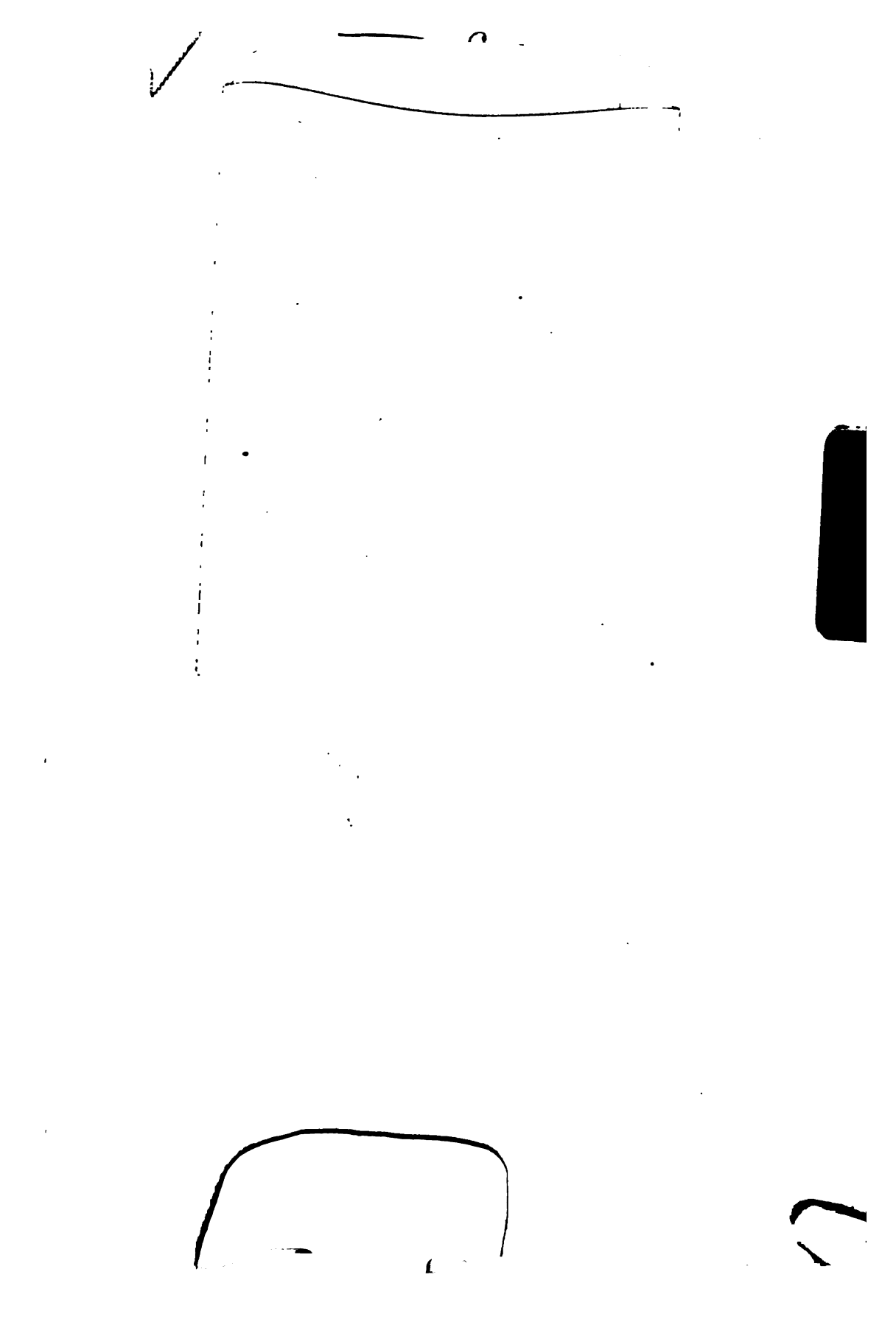
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